Metropolitan St. Louis Sewer District
CAPACITY, MANAGEMENT, OPERATIONS, AND MAINTENANCE (CMOM) PROGRAM PLAN

October 27, 2012

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LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

BKLSH	Back Flush of Sewage from Cleaning Sewer
BMP	Best Management Practices
CAP	Corrective Action Plan
CCTV	Closed Circuit Television
CIPP	Cured–in-Place Pipe
CIRP	MSD's Capital Improvements and Replacement Program
CM	Corrective Maintenance
CMMS	Computerized Maintenance Management System
CMOM	Capacity, Maintenance, Operations, and Management
COUPON TEST	Test to measure rate of corrosion and loss of thickness of pipe material
CSI	Customer Service Inquiry
DEC	MSD's Division of Environmental Compliance (Engineering)
ENG	Engineer
ERO	Erosion
ERP	Emergency Response Plans
EM	Emergency Maintenance
FM	Force Main
FOG	Fats, Oils, & Grease
GIS	Geographic Information Systems
HR	Human Resources
I&I	Inflow & Infiltration
INV	Investigation
INPRG	Work order status is "In Progress"
MGD	Million Gallons per Day
MH	Manhole
MHI	Manhole Inspection
Missouri One	System that Missouri uses for one spot to call to locate buried assets prior to digging
MSD	Metropolitan St. Louis Sewer District
NDT	Non Destructive Testing
ORS	Overflow Regulation System
PACP	Pipeline Assessment Certification Program
PM	Preventive Maintenance
PS	Pump Station
Result Set	Automated Listing or Report of Information within the CMMS
RRR	Repair, Rehabilitation, & Replacement
SCADA	Supervisory Control and Data Acquisition System (Pump Station)
SR	Service Request
SSO	Sanitary Sewer Overflow
SSP	MSD's Sewer Separation Program or one of the assets used in this program
SWP	Storm Water Problem
WBU	Water (Building) Backup
WO(s)	Work Order(s)
WORKSTOP	Status a work order is put in until condition hindering work is removed

1.0 INTRODUCTION

A Consent Decree between the United States of America, the Missouri Coalition for the Environment Foundation and Metropolitan St. Louis Sewer District ("MSD") in the matter of *The United States et al. v. The Metropolitan St. Louis Sewer District*, No. 4:07-CV-1120 (E.D. Mo.) has been entered with an Effective Date of April 27, 2012. Pursuant to paragraph V.G.31, 32, and 33 of Consent Decree Case No. 4:07-CV-1120, MSD is required to submit a Capacity, Management, Operations, and Maintenance (CMOM) Program Plan. This document is the formal submission of the CMOM Program Plan, and as noted on the cover page, is within six months of the Consent Decree Effective Date.

MSD's CMOM Program Plan incorporates asset management-based, preventive and predictive maintenance processes in order to keep the wastewater collection system in good repair and help achieve pre-established management and service level goals. The Program Plan helps the District better understand how the sewer system works under various conditions, and identifies maintenance and improvements needed to achieve established goals. As a result of this program, capital investment will be preserved while minimizing service interruptions such as Building Backups and Non-Capacity Sanitary Sewer Overflows (SSOs) resulting from blocked sewers or lines with capacity limitations or infiltration/inflow (I&I). Understanding capacity, and appropriately managing, operating, and maintaining the collection system is a top priority for MSD.

1.1 Organization

MSD is an organization chartered under the State of Missouri Constitution to manage wastewater collection and treatment for all of St. Louis City and most of St. Louis County. In addition to seven wastewater treatment plants, MSD operates and maintains the collection system. This includes pump stations but excludes lateral lines, septic tanks, and privately owned low pressure pumping stations. MSD is responsible for sewers from the point of the customer's lateral line connection into the public sewer all the way to the wastewater treatment plant.

The Operations Department is organized into divisions. The Collection System Division (or Yards) is responsible for the operation and maintenance of the publicly owned sewer assets in the collection system. The Pump Station Division is responsible for operation and maintenance of publicly owned pump stations that are a part of the collection system. Support staff handles customer calls, operation of warehouses, and administration of the asset management plan. See Appendix A.1 and A.2 for MSD organizational charts. See Appendix A.3 for a map showing the Pump Station maintenance group locations and division of Collection System Yard areas within MSD's service area.

The Yard and Pump Station employees perform operation, maintenance, and field engineering duties. Staff at the Yards is broken down further into maintenance, rehabilitation, and construction groups. Contractors are used for maintenance activities and emergency support when necessary to perform larger scale emergency repairs or augment staff when needed to meet cleaning, inspection, repair, rehabilitation, or replacement goals or complete agreed projects.

MSD currently has 3 Yards (Mintert, Sulphur, and Grand Glaize) among which collection system assets have been split to cover maintenance and operation geographically. There are currently three Pump Station operations and maintenance groups (Bissell Point, County, and Lemay) among which individual pump stations have been split to cover maintenance and operation responsibility.

As an example of interagency coordination, the Engineering Department within MSD helps as needed to oversee contractors and projects. Within the Engineering Department is the Division of Environmental Compliance (DEC) that oversees the Fats, Oils, and Grease (FOG) program and helps address problems related to grease found in the collection system. The Human Resources Department assists with development and conducting of training.

1.2 Information Management & Geographic Information Systems (GIS)

MSD has set up computerized information management systems to provide consistency of data on assets across the organization; help in efficient and effective planning, scheduling, and accomplishment of work; and help in analysis of asset performance. MSD utilizes a geographical information system software (GIS) and computerized maintenance management system software (CMMS).

A GIS group within the Engineering Department maintains digital maps showing collection system assets, pump stations, force mains, and FOG commercial establishments along with parcel boundary information from St. Louis city and county, street locations, address locations, and aerial maps. The GIS is the master database for collection system assets maintained by the Yards. The CMMS for maintenance management was initially loaded with assets from GIS and has been configured to receive any collection system asset updates that are input into GIS.

The CMMS is also configured to interface with the GIS. The GIS maps show locations of service request calls from customers and work orders generated in the CMMS. Staff performing work on the collection system, force mains, and pump stations have access to these maps as a part of the CMMS.

1.3 Collection System Assets and Description

MSD is the fourth largest sewer agency in the country based on miles of sewer. It's sanitary and combined sewer system is approximately 6,300 miles. There are also approximately 163,000 manholes that are a part of the sewer system. MSD currently maintains 233 sewer pump stations and 130 miles of force mains in its sewer collection system. MSD also maintains 36 floodwall and Overflow Regulation Stations (ORS) along the Mississippi River and River Des Peres which typically only operate in high river levels. Additionally, MSD has responsibility for the area's storm system and sewer lines leading from inlets to the combined sewer system. MSD refers to these inlet lines as inlet laterals. These storm assets are not included in this plan.

2.0 SEWER SYSTEM ASSET MANAGEMENT PROCESS

2.1 Program Overview

The components of MSD's CMOM Program Plan include the following:

- Scheduled cleaning and inspection of all gravity sewers with more frequent cleaning of those lines with a history of blockages or debris such as fats, oils, grease (FOG), and roots;
- Aggressive sewer lining to minimize root intrusion, inflow and infiltration; prevent premature structural damage, SSO's and Building Backups;
- Manhole inspections, repairs, rehabilitation, and replacement;
- Recording of maintenance activities in a computerized maintenance management system (CMMS) for appropriate analysis and ease of reporting;
- Recording, investigating, and resolving customer complaints as well as engineering review, when appropriate, to correct underlying system problems;
- Condition rating of sewer lines by CCTV (Closed Circuit Television inspection) and manholes with historical tracking of these ratings to aid repair, rehabilitation, and replacement decisions;
- Standardized work processes and flows for consistency in work performance, system repairs, data collection, data integrity, and training MSD staff;
- Pump station inspections, maintenance, repair, and system testing;
- Scheduled force main visual and non-destructive testing including all appurtenances.
- Proactive inspection of FOG generating facilities and source investigation of excessive FOG found in sewer lines;

MSD's maintenance activities are outlined in standard process workflows and procedure documents. These standard processes facilitate consistent practices and training.

2.1.1 CMOM Workflow Overview

A workflow overview of the CMOM Program Plan is provided in Appendix B and includes the following components – computerized asset database; sewer cleaning; inspection and investigation; repair, rehabilitation, and replacement programs. The CMOM Program emphasis is on proactive maintenance and quick response to emergencies with appropriate analysis to minimize reoccurrence. The GIS and CMMS databases interface and form the heart of this program.

For assets such as manholes, pump stations and force mains, condition and risk from the database drive the inspection program. Inspection results in assets being condition rated overall on a '1' to '5' scale with '1' being like new and '5' being near or at failure. Assets in poor condition are slated for replacement, rehabilitation or repair. For gravity sewers, preventive cleaning rather than inspection starts the process. The District has found it more cost effective to clean all pipes in order to maximize capacity and drive

inspection from information derived from cleaning. Similar to the above, inspection drives the rehabilitation and repair process. Prioritization of the rehabilitation and/or repair will be determined by assessing the information derived from cleaning and inspection along with other data in the CMMS.

2.2 Service Levels and Asset Risk

MSD recognizes that meeting service level goals in a cost effective manner requires an asset management approach. That is, meeting goals for customer service and regulatory compliance requires focusing limited resources on assets with condition and risk that pose the greatest impact on these goals.

MSD's CMOM Program Plan incorporates an asset management approach and has been prepared to help MSD effectively manage the wastewater collection system. In accordance with Consent Decree section V.G.31 the District has developed the following service levels:

1) One Basement Backup per one thousand homes (customer accounts), annually, excluding greater than five year rain events
2) 2.5 non-capacity related SSO's per one hundred miles of sewer system pipe annually
3) Emergency response within four hours at least 85% of the time for priority 9 building backup and manhole overflow calls, with the exception of greater than five year rain events or other extenuating circumstances
4) 96% compliance in completing gravity sewer cleaning and pump station preventive maintenance (PM) inspections.

MSD recognizes that basement backups and overflows due to system failure are undesirable and will strive to minimize them. However, no system, regardless of how well maintained will be without backups or overflows. The above goals have been established to achieve cost effective system operation. The building backup and SSO goals already represent greater than 50% reduction from historic levels.

MSD considers timely response to all customer calls extremely important and recognizes the importance of routine preventive maintenance. However, in an attempt to balance efficient operations, staffing levels and associated costs, MSD's customer response and pump station PM inspection goals above are set to recognize that situations will arise such as extreme weather, flooding, or other factors. These factors could prevent timely response or require scheduled preventive maintenance to be deferred until higher priorities have been addressed.

MSD uses asset management principles to analyze asset condition and risk (age, material, location, trouble history, and internal inspection results) to set inspection, maintenance, repair, rehabilitation, and replacement levels. For example, we previously determined that 95% of building backups occurred in clay pipe (typically more than 40 years old), less than 12 inch in diameter. Therefore, we established and completed a plan to clean this pipe within a 5 year period and as a result saw basement backups decline.

Section V.G.33 of the Consent Decree recognizes performance against service level goals may vary from year to year depending on the circumstances encountered in that year. MSD monitors performance against service levels. As more information is gathered on system performance, changes to Asset Management Performance Standards may be recommended. Any proposed changes will be based on a three year trend varying from the goal by more than 20% for building backups and SSO's or varying by more than 2% for customer response and PM compliance goals. Modifications in Asset Management Performance Standards will only be proposed as long as performance against service level will still be maintained.

3.0 GRAVITY SEWER SYSTEM ASSET MANAGEMENT PERFORMANCE STANDARDS & PROCEDURES

For collection system assets, MSD has established maintenance and inspection activities and set frequency for these activities with the goal of meeting service levels and complying with the Consent Decree. Upon approval and implementation of this CMOM Program Plan, requirements of the Consent Decree will be prorated for the corresponding reporting periods.

Consent Decree section V.G.32 states "If, in any year, MSD CCTV inspects, cleans, repairs, rehabilitates, or replaces more pipes, manholes or Force Mains than stated above, MSD may bank the excess to be applied against a future year's requirement in the same category. As part of its Annual Report required by Paragraph 73, MSD shall identify the number of miles MSD proposes to bank for each category and document the basis for MSD's position that it has exceeded the mileage or activity requirements in this Consent Decree. The banking account for each individual category will constitute the immediate past three (3) years, provided that once banked miles have been used they cannot be used in any subsequent year."

MSD has a 5 year and 10 year requirement for cleaning sewer pipes 21" or less in diameter depending on pipe material. In order to level workload and resources and simplify reporting, MSD has established annual targets for cleaning equal portions of the system over these required periods. For example, for the 5 year requirement to clean non-plastic sewers, the annual goal would be 20% of the total mileage. The District will report against this internal goal annually and utilize the banking provision for any excess. These targets would not be hard requirements but would be used to track annual progress toward the multiyear goal. Any overage in the previous 3 years can be used to bring annual performance up to the target. At the end of the required 5 or 10 year periods, all cleaning done over that time would be used to show compliance with the multiyear requirement. While the intent is to clean all sewers within their required timeframe, MSD will utilize the 96% compliance service level goals established in Section 2.2.

MSD's processes and frequencies are designed to maintain functionality of assets, reduce building backups and SSO's. This facilitates reduction of emergencies and helps achieve on-time response for the remaining emergencies. MSD will update the techniques and details of these processes along with maintenance and inspection levels as the system

performance levels are analyzed and as new information and technology become available and are determined to be appropriate.

District processes include: inspection of sewer lines via closed circuit television cameras (CCTV) with defect coding and overall rating of condition; cleaning (every 5 years for non-plastic and every 10 for plastic) sewer lines with diameters of 21 inches or less, cleaning as needed of lines with diameters greater than 21 inch; and manhole inspection. Each process has a workflow included in the appendices of this plan. For each process, specific information is required and entered in predefined fields in the CMMS. Analysis of this data facilitates any necessary follow-up inspections or work.

The table below represents how MSD characterizes pipe as plastic or non-plastic for purposes of determining maintenance and inspection levels:

Code	Description	Group
ACP	Asbestos Cement	Non-Plastic
BRK	Brick	Non-Plastic
CIP	Cast Iron	Non-Plastic
CMP	Corrugated Metal	Non-Plastic
CON	Poured-in-Place Concrete	Non-Plastic
DIP	Ductile Iron	Non-Plastic
LRCP	Lined Reinforced Concrete	Non-Plastic
MIX	Mixed Materials (Stone/Brick)	Non-Plastic
MXW	Mixed Material - Wooden Bottom	Non-Plastic
NCP	Non-reinforced Concrete	Non-Plastic
NSCL	Non Structural Cement Liner	Non-Plastic
PCP	Pre-stressed Cylinder Concrete	Non-Plastic
RCB	Reinforced Concrete Box	Non-Plastic
RCP	Reinforced Concrete	Non-Plastic
RCPP	Reinforced Concrete Pressure	Non-Plastic
SCL	Structural Cementious Liner	Non-Plastic
STL	Steel	Non-Plastic
STN	Stone Masonry	Non-Plastic
TECL	Tunnel in Earth, Concrete Lined	Non-Plastic
TRCL	Tunnel in Rock, Concrete Lined	Non-Plastic
TRUL	Tunnel in Rock, Unlined	Non-Plastic
UNK	Unknown	Non-Plastic
VAR	Variable Material	Non-Plastic
VCP	Vitrified Clay	Non-Plastic
VSB	Vitrified Segmented Block	Non-Plastic
ABS	Acrylonitrile Butadiene Styrene	Plastic
C900	C900 PVC	Plastic
CPP	Cured-In-Place	Plastic
FRP	Fiberglass Reinforced	Plastic
HDPE	High Density Polyethylene	Plastic

PEP	Polyethylene	Plastic
PLP	Plastic Lined	Plastic
PVC	Polyvinylchloride	Plastic
RPM	Reinforced Plastic Mortar	Plastic

3.1 CCTV/Gravity Sewer Inspection

3.1.1 Program Plan, Priorities and Goals

Inspection of sewer lines is primarily done by CCTV inspection. MSD has inspected a significant portion of its sewer collection system from 2005 to the present. After implementation of this Program Plan and until approval of the Master Plan required by the Consent Decree, MSD will annually inspect a minimum of 120 miles of 12 inch or less diameter non-plastic sewers. In addition, upon implementation of this program plan MSD will inspect no less than 280 miles of sewer annually until the entire system has been completed. Any additional inspection of sewer lines above the annual requirement will be banked and may be used in any of the subsequent 3 year periods to offset the amount of sewers that would need to be inspected in those years.

Priority has and will continue to be placed on 12 inch or less diameter non-plastic sewer pipe. MSD has determined that the majority of building backups are associated with blockages in these sewers. Secondly, priority will be placed on non-plastic pipe greater than 12 inch diameter and lastly on plastic and sewers lined with cured-in-place plastic greater than 20 years old. Priorities of this program will continue to be reviewed and adjusted as more information on asset condition and risk and system performance is obtained.

A workflow of the sewer inspection CCTV process is included in Appendix C. CCTV work can result from the following:

- scheduled routine inspection of sewers
- investigation of a customer call determined to be caused by either a blocked main, sanitary sewer overflow, or other sewer problem;
- investigation of problem areas identified by MSD's Engineering Department including DEC (Division of Environmental Compliance) for various reasons such as I&I studies and to aid FOG commercial establishment inspections;
- investigation of problems identified by MSD crews such as discovery of large amounts of debris, roots, or grease and defects discovered during manhole inspections;
- inspection of repaired or rehabilitated sewers to update their overall condition rating.

For each requested sewer line inspection, a work order is generated in the CMMS with one of several classifications of CCTV work. Following is a list of current classifications and their descriptions:

Classification Code	Description
FBTVC	Determine Cause of Cave-in
FBTVG	Grout Joints with Packer
CIPP	Cured in Place Pipe Rehabilitation & TV Re-inspection (Contractor)
FBTVBM	TV Blocked Mains
FBTV ROOTS GREATER THAN 1	TV for Excessive Roots, Debris, or Grease Found During Cleaning
FBCCI	Crawl Crew Inspection
FBTVI	TV Inspection

3.1.2 Blocked Main and Corrective TV Work

If a building backup or non-capacity sanitary sewer overflow (dry weather SSO) occurs and the cause is determined to be a blocked main, the CMMS automatically generates an FBTVBM work order to have the sewer line inspected along with an engineering referral for review. If routine or regular cleaning identifies excessive levels of roots, grease, or debris, the CMMS will automatically generate an FBTV work order to identify the intrusion. If excessive amounts of grease are removed, the CMMS will also automatically generate a work order to trigger investigation by DEC of FOG generating facilities discharging to the blocked sewer. MSD contracts for installation of cured-in-place liners for some sewers. The contractor televises and defect codes these lines after installation and provides the video and results to MSD. This TV work and rehabilitation is documented in the CMMS using the CIPP work order classification.

3.1.3 Routine CCTV Sewer Inspection

For routine sewer inspection, the FBTVI work order classification is used whether MSD crews or contractors perform the work. These routines are set up in the CMMS by building and sequentially scheduling routes of assets based on maintenance service areas, treatment plant watershed, pipe cleaning activities (which put more priority on 21 inch or less non-plastic pipe), and pipe material (non-plastic versus plastic pipe).

3.1.4 Documentation of Inspection and Follow-up Work

All work is assigned or scheduled with the vendor, crew and/or work order owner on the work order record. The actual CCTV inspection of the sewer is done by contractors or MSD crews whose trucks utilize CCTV inspection software and have digital or analog truck cameras or other camera equipment.

MSD has established a standard set of codes and severities that are similar to Pipeline Assessment Certification Program (PACP) but have been tailored to the types of sewers in MSD's system. These defect codes and severities are used to calculate an overall score and condition rating for each asset. Videos and inspection records are uploaded from trucks or from contractors and stored in a "corporate" inspection database for possible review. Video from sewers currently rated overall as a '4' or '5' are stored in this database along with a sample of videos of other sewers. Data from the "corporate" inspection, including the overall asset score, is fed via a preprogrammed interface back to MSD's CMMS and updates the work order and the asset record.

If an individual pipe defect of severity '4' or '5' that requires repair is discovered during the inspection, crews have been instructed to create a follow-up work order with the recommended repairs. Certain individual '5' defect codes result in an overall asset rating of '5' which needs to get fixed within 1 year (see the Acute Defect Process section below). If a defective lateral is discovered, it can be referred to municipalities for repairs or assessed for inclusion in the Supplemental Environmental Project administered by MSD as required in Consent Decree section X[1]. Once repairs are completed, another inspection is conducted to update the asset's condition rating.

3.2 Sewer Line Cleaning and Root Control

3.2.1 Asset Management Approach

MSD has adopted an aggressive cleaning program as the foundational step in a proactive, asset management based approach to sewer line maintenance and root control. Routes of assets based on treatment plant watershed, type of pipe, and risk (material/age, location, trouble history calls/inspection results) are built in the CMMS to accomplish sewer cleaning. The District has found it more cost effective to proactively clean all pipes in order to maximize capacity and drive CCTV inspection from information gathered while cleaning. A work flow of the cleaning and root control program is included in Appendix D of this plan.

MSD cleaned over 7,000 miles of sewer system from 2005 through 2011. This cleaning program emphasized vitrified clay pipe which is typically 40 years old or more and has a higher rate of trouble calls, including root intrusion. Cleaning of sewers has been successful in reducing building backups and SSO's and improving service levels within the constraints of the sewer system's design (5 year rain event minimum). Generally, MSD tries to clean topographically from the top of a watershed to the wastewater treatment plants and starts over again to keep the system clean. Information gathered during sewer cleaning is used to identify areas needing sewer inspection and possible sewer rehabilitation. Historically, this asset management approach of letting cleaning drive inspection has yielded higher service level results in a more cost effective manner.

MSD has committed to cleaning all of the 21 inch or less non-plastic sewers at least once every 5 years and all plastic sewers of this size at least once every 10 years. While there are no hard annual requirements in the Consent Decree, MSD has established annual sewer cleaning targets based on the amount of each type of sewer in the system and works toward cleaning sewers equally throughout the required period. The portion of each annual report showing progress against the annual goal will exclude duplicate cleaning of any asset during that 5 year period. Response to major weather events could create annual fluctuations in the amount of pipe cleaned. MSD will track performance against these established annual targets and utilize banking for overages or underage in any year to monitor progress against the overall 5 and 10 year requirement to clean the entire non-plastic and plastic pipes, respectively, of the system.

[1] "This project was undertaken in connection with the settlement of an enforcement action, United States, State of Missouri, and the Missouri Coalition for the Environment Foundation v. Metropolitan St. Louis Sewer District, No. 4:07-CV-01120-CEJ, taken on behalf of the U.S. Environmental Protection Agency, the State, and the Coalition under the Clean Water Act."

Sewer pipes larger than 21 inch diameter will not be routinely cleaned but will be routinely inspected and cleaned as necessary to prevent loss of needed hydraulic capacity.

3.2.2 Proactive/ Routine Cleaning

Routine cleaning starts with information derived from the CMMS. MSD staff divides sewer assets into cleaning routes based on pipe size, pipe material, watershed, and trouble history. Currently, plastic pipe 21" diameter and less is considered low risk and is cleaned on a 10 year cycle. Non-plastic pipe less than 21" diameter is considered higher risk and is cleaned on a 5 year frequency. Some assets identified as "hot spots" have been put on higher (1 or 2 year) cleaning frequencies. This happens when MSD has identified a history of repetitive problems or when potential problems have been identified from internal inspections.

3.2.3 Emergency and Corrective Cleaning

Not all sewer pipe cleaning is proactive. Sewer cleaning may result from response to customer service requests such as building backups or SSO's. Customer Care staff documents these service requests in the CMMS with predetermined problem classifications and priorities. A work order is created for the collection system maintenance department, and emergencies are assigned directly to crews. The responding crew determines if sewer cleaning is needed after they investigate the customer request. If cleaning is required then MSD will clean the sewer.

3.2.4 Documenting Cleaning Results and Follow-Up Work

Whether cleaning is the result of a customer call or from proactive maintenance, MSD gathers a standard set of information regardless. Classification of the cleaning type performed is documented on the work order along with the amount and type of debris removed. Debris types include grease, roots, and grit. If determined, it is also noted on the work order whether the sewer was blocked and the location of the blockage. These work orders are preserved within the CMMS and may be reviewed as necessary.

MSD currently uses the following methods (recorded as work order classifications in the CMMS) of sewer cleaning and root control:

Classification Code	Description
CS	Cobra Saw (primarily for non-plastic pipe)
HF	Hydroflush (primarily for plastic pipe)
HFDG	Hydroflush with Degreaser
RH	Rodded by Hand (in special circumstances)
RTFM	Root Foaming
BUCKETING	Mechanical removal of debris

Periodically, debris type and quantity discovered during cleaning is reviewed by MSD staff to ensure appropriate cleaning frequencies. As covered under the CCTV inspection program in section 3.1, excessive debris or sewer line blockages discovered during cleaning automatically generates work orders for follow-up CCTV inspection and/or FOG commercial establishment inspection (grease). For all work orders coded blocked

main (BLM), the CMMS automatically generates a follow up work order for Operations Engineers to review asset history and CCTV results. These follow up work orders and reviews assure the source of the problem is found and the correct repairs are performed in a timely manner. If an MSD crew determines that a building backup resulted from a MSD sewer blockage or overcharge, customer information is automatically interfaced from the CMMS to the vendor handling MSD's insurance program so they can begin resolution.

The 5 and 10 year frequencies and asset classifications of this proactive cleaning and root control program will continue to be reviewed and adjusted as more information on asset condition and risk and sewer system performance is obtained.

3.3 Manhole Inspection

MSD has met the requirement of inspecting 75,000 of its 163,000 sanitary and combined system manholes from 2008 to no later than 3 months from the Effective Date of the Consent Decree. The District will inspect a minimum of 15,000 manholes each year with a goal to inspect all manholes in these systems every 10 years. Any manholes inspected beyond the 15,000 requirement each year would be banked and could be used to offset the amount needing to be done in any of the subsequent 3 years. The workflow for this program is included in Appendix E of this plan.

3.3.1 Inspection Process

Routine manhole inspection starts with information derived from the CMMS asset database. MSD's Engineering Department may request manhole inspections for I&I or other trouble areas. Manhole inspections are prioritized with consideration of the following: have not been previously inspected; are located in areas that have high I&I or overflows. MSD staff divides manholes into routes based on watershed. Planners generate work orders and then assign these inspections to crews. Work orders for manhole inspection can also be written during other inspections such as CCTV if they think repairs may be needed.

Many of MSD's manholes are in heavily wooded rear easements, under sheds, inside of buildings or possibly paved over. The first step in the inspection process is locating the manhole. If the field crew cannot locate the manhole, they will refer it to an engineer located at their Yard. The Yard Engineer will review whether the system is mapped incorrectly. If the crew cannot access the manhole, they will refer it to either a CCTV crew to locate the manhole and, if necessary, refer for repair to raise the manhole. The inspection work order is put in a status of "WORKSTOP" until the repair or review is complete. If MSD determines the manhole doesn't exist, GIS map updates are made and the inspection work order is cancelled. Updates to assets in GIS cause the corresponding asset record in MSD's CMMS to also be updated.

3.3.2 Manhole Condition Ratings

To systematically rate manholes, MSD has developed a pictorial manhole inspection guide. For each individual component of the manhole, inspection crews capture material, defects, and overall condition rating. Each component is rated based on the severity of

defects according to the pictorial guide. The rated manhole components are the cover, frame, frame adjustment, frame seal, cone, wall (or barrel), bench, trough, steps and pipe connections. Each component is given a rating of '1' to '5' similar to televised sewers. During the inspection, pictures of significant defects are taken for attachment to the work order. Additionally, if pipes entering the manhole appear to have significant defects, they may be referred for further inspection by CCTV.

After inspection, the manhole is given an overall condition rating of '1' to '5' based on the worst individual components. This overall rating excludes steps which are not considered essential since tripods can be used and covers which are replaced during the inspection. These ratings are documented on the work order. The overall rating is transferred automatically to the asset database in the CMMS which maintains a history of these asset ratings.

3.3.3 Follow-up Repair and Re-inspection Work

The manhole inspection process feeds the manhole repair, rehabilitation, and replacement (RRR) process. Follow up work orders are written to repair any manhole component rated a '4' or '5' and as needed for the connected pipes. These work orders are classified based on the type of work recommended for the defects observed (see section 3.4.2 Manhole RRR, for the types of repairs). Operations engineers review for adequacy what repairs and priority are recommended on manholes rated a '5'. Once manhole repairs are completed, the components of the manhole are re-inspected and given an updated overall condition rating. The asset record in MSD's CMMS is updated with this rating.

3.4 Repair, Rehabilitation, and Replacement (RRR)

MSD's RRR process has been established to help meet service levels, ensure defects don't compromise the sewer system, to sustain the system and to prevent overflows and reduce sources of excessive inflow and infiltration.

The type of repair recommended and priority is based on the criticality and condition rating as determined during inspection and maintenance. CMMS work priorities are time based indications of when the work is expected to be completed. They range from 4 hours for emergencies to over 1 year for work such as capital projects.

RRR work orders in the CMMS are "classified" based upon the type of work such as sewer lining, and manhole lining. These classifications will be discussed in the manhole RRR and sewer RRR sections below. All RRR work included in these classifications are designed to bring the life of the repaired section at a minimum up to the remaining life of the whole asset. If repairs are done, they should bring the asset condition rating up to a minimum of '3'.

3.4.1 RRR Process Overview

RRR work orders follow MSD's process as outlined in the work flow in Appendix F. Recommendations for repair, rehabilitation, and replacement of sewer assets come from MSD's various inspection processes. These inspections can be performed by contractors or MSD crews and include proactive CCTV and manhole inspections; I&I study driven

CCTV and manhole inspections; pump station inspections; force main inspections; as well as emergency or corrective maintenance.

For all the sources above, staff has been instructed to write follow-up RRR work orders if during an inspection a sewer or manhole is given an overall condition rating of '4' or '5'. This assures that RRR is done proactively before failures occur. For sewers, an overall '5' rating is considered acute and needs to be repaired within 1 year. A '4' rating means repairs are recommended before the next inspection cycle. Assets with ratings of '1' through '3' are in a condition to last beyond the next inspection.

For every CCTV inspection that results in an overall '5' condition rating, MSD's CMMS automatically generates an additional follow up work order for an Operations Engineer to review compliance. The engineer's review ensures the asset will get the most appropriate RRR work done and that it carries the correct priority. The engineers also ensure follow-up inspections occur and the asset gets an updated condition rating in the CMMS after the repairs are completed.

The remaining RRR work orders are routed for review by various staff depending on the desired type of repair. During this review, a determination is made on what repair, rehabilitation, or replacement process they will go through. In some cases, MSD's Engineering Department assembles RRR work into projects to address some collection system areas that need major repair, rehabilitation, or replacement.

MSD has several processes which may generate RRR of sewers and manholes. External contracts have been established or are established as needed for more complex work and to balance repair work load. These contracts are used for work such as sewer lining (CIPP), sewer repair and manhole repairs. Repairs that are less than $25,000 utilize the Infrastructure Repair (IR) program. Repairs over $25,000 go through either the IR program or MSD's Capital Improvements and Replacements Program (CIRP). CIPP work is grouped into large CIRP jobs. All contracted work is overseen by the Engineering Department.

Construction and Rehabilitation Crews within MSD's Operations Department have been established to perform point repairs on sewers, slip lining sewers, spray lining manholes (SRS), and repairing manholes. Typically, rehabilitation is done when the asset is in need of repair but its structure is not compromised. Construction/replacement of a portion of a sewer line or manhole is done when the asset is structurally compromised.

After repairs or rehabilitation are done, the manhole or sewer is re-inspected and receives an updated asset condition rating and is rescheduled to receive its next appropriate inspection(s) or cleaning.

3.4.2 Manhole RRR

MSD has committed to permanently repairing, rehabilitating, or replacing at least 1500 manholes annually. The manhole RRR process follows what is outlined in section 3.4.1 above. If more than 1500 manholes are done in any given year, the extra amount will be banked for use against the 1500 requirement in any of the subsequent 3 years.

Manholes are repaired using either conventional dig or repair-in-place technologies. The following are classifications of work used in the CMMS for manhole RRR. Classifications can be added or dropped from this list as alternate technologies are developed, investigated, and determined to be appropriate:

Classification Code	Description
SRS	Structure Rehabilitation System – manhole lining system (repair in place technology)
PS	Plaster Structure – grout portions of the structure with various materials as needed
RMH	Repair Manhole – repairs such as partial manhole replacement
RPM	Replace Manhole – remove and replace manhole

As outlined in section 3.4.1, repairs on manholes with a poor asset rating (5) are reviewed by Operations Engineers so that the most appropriate type of repair is done. Non-emergency repairs handled internally by MSD are scheduled by planners based on priority. After emergency or scheduled repairs are done, the same crew performing the repairs does a follow-up manhole inspection to update the asset's condition rating. If that crew has not been trained on manhole inspections, a follow-up work order is written to have the manhole inspected by a crew trained to perform such inspections.

MSD also tracks the number of manhole frame adjustments done annually. The following work order classifications are used for this purpose:

Classification Code	Description
RFR	Reset/ Replace Frame & Cover
RLM	Raise/Lower Manhole
RPR	Replace Riser

3.4.3 Gravity Sewer RRR

Annually MSD will permanently repair, rehabilitate or replace 90 miles of sewer system for the first 10 years after April 27, 2012 and 65 miles of sewer annually thereafter. Sewers receiving an overall '4' or '5' asset condition rating as a result of a CCTV inspection would be a part of the sewer RRR. Sewers rated overall as a '5' are considered acute defects and will be addressed within one year of discovery as required by the Consent Decree. This work will total at least $15 million annually until the Master Plan is submitted. Any sewer RRR work done in excess of the annual requirements will be banked for use against requirements in any of the subsequent 3 years.

Sewers are repaired using either conventional dig or repair-in-place technologies. Following are the classifications of work used in the CMMS for sewer RRR. Classifications can be added or dropped from this list as alternate technologies are developed, investigated, and determined to be appropriate:

Classification Code	Description
CIPP	Cured in Place Pipe – plastic liner installation
DSJ	Dig/Crawl to seal joints
RPLMAIN	Replace Sewer Main (replace full length)
RPRMAIN	Repair Sewer Main (dig to repair or replace section)
SL	Slip lining Sewer

As outlined in section 3.4.1, repairs on sewers with an overall poor asset rating (5) are reviewed by Operations Engineers so that the most appropriate type of repair is done within the correct priority (see the Acute Defect Process below). Non-emergency repairs handled internally by MSD are scheduled by planners based on priority. After repairs are done, the crew performing the final repair writes a follow-up work order to have the sewer re-inspected so that the asset's condition rating can be updated.

3.4.4 Acute Defect Process

MSD has developed a process to ensure that all acute defects on sewer lines are repaired within 1 year of discovery as required by the Consent Decree. Processes have been developed for repairs discovered during routine inspections as well as emergency and corrective maintenance. Acute defects are defined as those sewer defects that have caused or substantially increase the risk of a SSO, including conditions leading to imminent structural collapse or that would create repeated blockages. The Acute Defect workflow process is found in Appendix G.

CCTV inspections of sewer lines determine if they have an acute defect that needs repair. In addition to verbally communicating the defect, crews conducting sewer line inspections and crews performing emergency or corrective sewer maintenance have been trained to assign an overall asset condition rating of '5' on any sewer work order on which they discover an acute defect. Contractors working for MSD have been instructed to call MSD on the day they discover any sewer with an acute defect. The person overseeing these contracts also assigns an overall asset condition rating of '5' on the CMMS work order for that asset.

The CMMS automatically picks up sewers with an overall acute defect score of '5' and each night creates an additional "acute defect" work order which is assigned to Operations Engineers. Operations Engineers automatically see a list of these work orders in the CMMS. These work orders are used to maintain an electronic log of discovered acute defects with the date of discovery and the completion date of the permanent repair. Operations Engineers review recommended repair work orders written up by crews to ensure they will correct the structural defect in a manner that will give the sewer the same or greater life expectancy as the remainder of the pipe segment. They also monitor and document completion of the work within the required time and ensure the asset gets re-inspected and assigned a new condition rating.

3.5 Standard Asset Management Procedure Workflows

MSD utilizes work flows and corresponding training materials to help ensure quality asset operation, evaluations and maintenance work. These materials are essential to maintain good documentation in the CMMS of customer complaints, work orders for routine and emergency maintenance, and updates to sewer system asset inventory. Standard problem coding and response procedures have also been adopted and preprogrammed where appropriate into the CMMS.

MSD updated standard procedure work flows for collection system assets during the 2011 implementation of an upgraded CMMS. MSD will continue to update these work flows and training materials, including the 2 year training program for new hires, as needed for addition of new system functionality. Training materials and process flows will also be updated as the District refines its asset management and maintenance practices.

MSD has provided and will continue to periodically conduct training for maintenance staff so that problems which could lead to non-capacity related SSO's are appropriately addressed. Contractors are evaluated and informed through bid qualifications, specifications, bid review, contract documents, and contractor meetings to ensure they have sufficient knowledge and ability to promptly identify and address problems in the Sewer System.

Work flows for documenting customer complaints; routing of work orders/emergency response; and asset modification, creation, and decommission (updates to inventory) are included in Appendices H, I, and J respectively and will be discussed in this section.

3.5.1 Customer Complaints

MSD has Customer Care personnel scheduled around the clock to receive calls or e-mails for customer service requests and enter these into the CMMS based on standard operating procedures. If a major rain event results in higher call volumes than this group can handle, additional District staff are used to receive calls.

Each type of call (or request) is preprogrammed in the CMMS and carries a standard priority that is automatically populated on that service request. If necessary, Customer Care staff can adjust these priorities in compliance with standard operating procedures based on information received during the customer contact. The current list of standard service request classifications and priorities for initial response are contained in the table below:

Classification Code	Description	Priority Code
BFLSH	Back Flush	9
BLC	Blocked Creek/Creek Inspection	7
BLI	Blocked Inlet	6
BRP	Broken Pipe	9
BS	Broken Stone	7
CI	Cave-in	7

CD	Claim Dispute	7
CSI	Customer Service Inquiry	-
ERO	Erosion Problem	7
FLD	Flooded Street	9
HLP	House Line Problem/Program	6
LLF	Leaking/Loose Frame Repair or Replace	8
LMH	Locate Manhole/Main/Force Main	7
MA/BG	Manhole Above/Below Grade	3
MHH	Manhole Holding	9
MHO	Manhole Overflowing, Seepage, Sewage	9
MCV	Missing Cover	9
ODR	Odor Problem	9
OTH	Other/Miscellaneous	-
SEP	Seepage	9
SEW	SEWAGE	9
SSF	Sewer Separation Failure	9
SSP	Sewer Separation Program Request	7
STO	Stone Out	9
SWP	Storm Water Problem	7
VER	Verify Connection	5
VPO	Vent Pipe Overflow	9
WBU	Building (Water) Backup	9

The table below defines the target response time associated with each priority:

Priority	Target Response Time
10	2 Hour (Emergency Locates Only)
9	4 Hours
8	24 Hours
7	48 Hours
6	5 Days
5	30 Days
4	60 Days
3	90 Days
2	6 Months
1	1 Year
0	Greater than 1 year

When calls are received by Customer Care, they check the CMMS to see if MSD has sewers in the vicinity or to determine whether or not the problem potentially involves MSD assets. The CMMS includes GIS mapping of service requests and work orders to aid this process. Customer Care also enters notes and attachments from the call or correspondence and the address of the problem (and mailing address if different) from a preprogrammed list of addresses within the CMMS. The customer is directed to other MSD departments or companies if it is not an MSD sewer maintenance problem. If MSD will respond, the customer is given the service request number for future reference. Addresses not in the preprogrammed list go thru a resolution process to get added if needed to the CMMS.

Customer Care staff also receive requests from Missouri's One Call system for locating sewers prior to excavation as required by state law. These requests are documented as "Locate" service requests in MSD's CMMS.

If a customer call problem is related to a previous service request, Customer Care staff creates a new service request but does not create a new work order. The new service request is linked in the CMMS to the existing work order so the assigned crew can follow-up more efficiently on both problems at the same time. If it is not related to previous calls, a work order is created from the new service request.

3.5.2 Work Order Routing and Accomplishment

Work orders can come from one of three sources: calls to Customer Care, MSD staff creation, and scheduled preventive maintenance work generated by planners. MSD has established a workflow to ensure all work orders are responded to appropriately. The workflow included as Appendix I covers MSD gravity sewer assets and initial response to customer problems. More details on pump station and force main response will be covered in sections 4 and 5 of this CMOM Program Plan.

Most emergency work originates from customer calls. For customer calls with response priority of 9, such as SSO's and basement backups, Customer Care assigns and immediately notifies crews to respond. If Customer Care determines that the call is from a chemical spill, they also notify MSD's DEC. If Customer Care is notified of a back flush (sewer cleaning causing back flow into buildings), a determination is made whether it is from a contractor or MSD crew. The responsible party is immediately notified. On occasion, crews also identify emergency work. When this occurs, the crew will create the work order and notify the appropriate crew or supervisor for prompt response.

When MSD crews respond to emergencies, they then determine the problem and take appropriate corrective action. Some problems require response from additional crews or MSD staff. If a sewage spill has occurred, the crew or Customer Care notifies DEC to coordinate spill cleanup and reporting. If a building's sewer separation pump (SSP) requires emergency maintenance, a contractor may also need to be called to resolve the problem. If MSD crews discover a problem with an MSD pump station or force main, the crew or Customer Care calls the Pump Station Division for prompt response.

Other non-emergency work orders are routed automatically within the CMMS to the appropriate person (supervisor, planner, or engineer) based on type of work requested (work order classification) and priority. Corrective maintenance work with priority 6, 7, or 8 that needs to be completed the same week is routed to supervisors who assign to their crews.

Planners assign all PM work and corrective work with priority 5 or less (greater than 1 week response time) that will not be covered by engineers. In order to level resources, planners develop a schedule and assign crews for longer term work that doesn't require engineers. Principal Engineers receive work orders that require engineering investigation or analysis such as sewer lines to be lined (CIPP classification), storm water problems, erosion problems, and requests for sewer separation projects to be installed.

Once the crew or engineer accomplishes their assigned work, they complete entries in the CMMS and change the status of the work order. Crew labor and vehicle time is entered. In addition, storeroom materials and items purchased and used on the work are charged against the work order. Problem, cause, and remedy employed are selected by the crew from preprogrammed hierarchy in the CMMS. Data for the type of work completed is entered into a standardized template. For example, length of sewer cleaned and whether there was any blockage is included in the standardized template for sewer cleaning work orders. Notes can also be added to the work order to communicate information not otherwise captured.

3.5.3 Asset/Equipment Updates

MSD's GIS is the database of record for gravity sewer assets. GIS is interfaced with the CMMS to automatically bring newly added or modified sewer assets into the CMMS. GIS staff is notified of changes or additions to assets by developers or contractors from the Engineering Department via as-built drawings or engineering reports detailing this work. The work flow process diagram for updating asset inventory is included in Appendix J.

If internal MSD crews accomplishing work identify a change that is needed to an asset, they initiate that change by either filling out the standardized template on that work order or creating a map update work order to notify GIS of the change. Certain asset data changes such as pipe material can be done using the standardized fields while asset location changes require a map update. GIS staff is notified of these changes by routing of work orders within the CMMS or reports that are periodically run. For certain classifications of work, such as replacing an asset, an asset change is always needed and GIS is automatically notified. GIS staff makes these changes in the map and sets that asset to be transferred into the CMMS.

Pump station and force main asset updates are covered in sections 4 and 5. CMMS is the master database for pump station and force main assets as these get broken down into smaller components against which work is performed. Updates or additions to these assets are made in the CMMS by Operations staff.

4.0 PUMP STATION ASSET MANAGEMENT PERFORMANCE STANDARDS AND PROCEDURES

4.1 Program Overview

MSD's Pump Station Division processes are incorporated into the District's asset management program to help ensure that pump stations are kept in good repair and function optimally. This program helps preserve existing capital investments, while concurrently minimizing service interruptions. The program also allows MSD to better understand how the system functions, how it works under various conditions, and what maintenance and capital improvements are necessary to achieve optimal system performance. Understanding capacity and appropriately managing, operating, and maintaining the collection system is an important goal for the District, and thus for the Pump Station Division. The program combines preventive, corrective, and emergency maintenance strategies with industry best management practices in order to most effectively manage sewer system asset inventory.

MSD currently operates and maintains 269 publicly owned sewer system pump stations for which the Consent Decree requires periodic inspection. This includes all pump stations that pump solely sanitary flows, those pump stations that pump combined wastewater and storm water flows, as well as 36 specialized pump stations that comprise the Overflow Regulation System (ORS) on both the Mississippi River and River Des Peres, but excludes pump stations that pump storm water only.

The ORS stations are located along the Mississippi River and River Des Peres. They are designed to protect the area from flooding when the river levels are high, sewer overflow gates are closed, and storm events could flood the region from within. They are idle when river levels are below flood stages and may operate only intermittently when river levels are at or above flood levels and the sewer overflow gates are closed. Like all pump stations in the District's asset inventory, the 36 ORS stations are monitored and alarmed on a daily, continuous basis by the District's Supervisory Control and Data Acquisition (SCADA) system. The SCADA system's remote monitoring will alert District staff of any events of malfunctions or emergency at the ORS stations.

Under section V.G.31.i.ii of the Consent Decree, the capacity of the ORS stations would classify them all to be inspected weekly. The intermittent use and lack of run time of these pump stations would make weekly inspections a potential misuse of valuable resources. Due to their infrequent operations, the 36 ORS stations will be treated as a special case. Instead of weekly, the ORS stations will be inspected a minimum of monthly and included in the Annual Report with the other pump stations classified for monthly inspections. This reclassification does not minimize their criticality. District protocol covers ORS pump stations during critical high river stage. When the river is above flood stage, the District assures specific stations are manned around the clock and the others have staff dedicated 24/7 to continual roaming station checks.

4.2 Pump Station Routine Preventative Maintenance Inspections

To reduce the risk of premature asset failure, pump station personnel perform periodic preventive maintenance checks and services on structural, electrical, and mechanical components. The District documents inspection results in the CMMS, which serves as the master database for pump stations. The information will be used to proactively determine rehabilitation cycles, life cycle and replacement. The work flow diagram for pump station inspections is found in Appendix K and described below.

1) Periodic preventive maintenance checks and services of pump stations will be conducted based on the defined peak hydraulic capacity of the pump station asset in the prioritized, risk based, asset hierarchy. There are 3 tiers:

a) Assets ranked in the higher hydraulic capacity range tier, i.e. peak hydraulic capacity greater than five (5) million gallons per day (MGD), will be inspected once per week.

b) Assets ranked in the next hydraulic capacity range tier, i.e. peak hydraulic capacity between one (1) and five (5) MGD will be inspected two (2) times per month.

c) As discussed above, ORS stations and other pump stations ranked in the next hydraulic capacity range tier, i.e. peak hydraulic capacity less than one (1) MGD will be inspected once per month.

2) Pump station inspection work orders are generated by Planners and scheduled to be completed by field personnel. The appropriate job plan for each station is included with each inspection work order. Because of the unique nature of each pump station, they may each have an individualized job plan. These job plans identify critical components of each station that need to be checked. At a minimum, the job plan checks include structural, electrical, and mechanical components. At less frequent intervals, other data may be collected and performance checks completed. During station checks, field staff will identify corrective or emergency maintenance required and create work orders in the CMMS when necessary.

3) The criticality of the pump station and asset condition rating may need to be updated, based on inspection results. This would be accomplished during periodic review of the data collected during inspections.

MSD has established a service level goal of 96% compliance with pump station PM inspections. The District recognizes the importance of routine preventive maintenance. However, in an attempt to balance efficient operations, staffing levels and associated costs, MSD's pump station PM inspection goals are set to recognize that situations will arise such as extreme weather, flooding, or other factors. These factors could require scheduled preventive maintenance to be deferred until higher priorities have been addressed.

Per Consent Decree section V.G.31.i.i, MSD has developed and will periodically update a hierarchical, prioritized ranking of pump stations based on estimated risk and consequence of failure. Factors included in risk of failure are typically linked to pump station physical attributes. Consequence of failure is typically linked to the location of pump station assets and design phase factors. Factors utilized as part of the criticality rating process include the following:

- age
- installed redundancy
- alternate power supply
- 5 year maintenance history
- location
- population affected
- environmental concerns

The criticality ranking may be used along with peak hydraulic capacity to recommend changes to some pump station inspection frequencies as more information on pump station performance becomes available.

4.3 Pump Station Emergency and Corrective Maintenance

In some cases, pump station inspections will result in Corrective Maintenance (CM) or Emergency Maintenance (EM) work orders that are designed to correct defects and/or deficiencies identified during the inspections. Pump station work orders from all sources are prioritized based on the CMMS rating scale, i.e. 1 to 10. MSD staff will prioritize work orders based on the criticality of the asset in the risk based hierarchy and the urgency of the work to be performed. The work flow diagram for pump station emergency and corrective maintenance is found in Appendix L and is described in the steps below.

MSD maintains a list of pump stations with data that includes installed redundant pump capacity, provisions for quick connection of emergency pumps, on-site alternative power system, provisions for quick connection of emergency portable power systems, storage, pumping system controls and alarm systems, lightning protection, criticality rating, pump size, and hydraulic capacity. This list includes backup generation requirements for each station to allow personnel to more quickly respond.

SSO's and building backups caused by pump station failures should be minimal as MSD designs all pump stations with redundant pumps so that peak daily flows can be handled with one or more pumps out of service. In addition, most stations have backup power from multiple utility company feeds or installed generators. Some lower capacity, lower risk stations which do not have backup generators have installed detention. MSD has accepted this approach since we constantly monitor pump stations through SCADA, maintain an inventory listing backup generators, and also have personnel on standby that can respond to emergencies, access pump station backup generation information and quickly correct any power outages or other problems. In all cases, MSD personnel

responding have access via portable computers to the CMMS including inventory and pump station data.

EM and CM work orders for pump stations can come from one of three sources:

1) When the SCADA system identifies a change in status of a pump station asset, 24-hour staff assigned to monitor pump station operation will dispatch pump station maintenance personnel to investigate. The SCADA system monitors multiple inputs, but focuses especially on the following types of alarms:

- Pump failure
- Power failure alarms – primary, or secondary power has failed.
- Backup generator - has activated or failed.
- High wet well level – water feeding the pump station has exceeded normal operating levels.
- Emergency high wet well level - a large amount of the station's emergency storage capacity has been depleted.
- Communications failures – the pump station alarms are not being transmitted

2) Pump station emergency and corrective maintenance may result from work orders originating from customer calls. Collection system yard personnel will typically respond first and assess the problem. If it is determined to be a pump station issue, a follow-up work order is created and referred to the pump station group.

3) Pump station inspections could also result in emergency or corrective maintenance work orders. Upon discovery of an emergency, the person performing the inspection will address the problem if they are able. Otherwise, an emergency work order is written and additional resources obtained, if necessary. If a non-emergency repair need is discovered, a CM work order is created as a follow-up to the inspection and it is referred for repair, rehabilitation, or replacement.

The time of day determines field staff's response to SCADA alarms or work orders from customer calls. During normal duty hours, an initial maintenance response is performed by an on duty field staff member assigned to one of four geographic areas. After normal duty hours, a designated standby person for the area is notified who then makes a determination as to whether or not immediate response is required. Any alarm or combination of alarms that could potentially lead to an overflow or building backup requires immediate response. If immediate response is required, the standby person for the area responds. If it is determined that immediate response is not necessary, the alarm is addressed at the start of the next business day.

When responding to a pump station emergency, regardless of the source, the field staff member on site will generate an emergency work order to perform the work if one does not already exist. The responding staff member will then assess the magnitude of the problem and determine the proper course of action. If an overflow has occurred, MSD's Division of Environmental Compliance (DEC) personnel are immediately called to assist in and document the overflow response. DEC's overflow response processes will be

conducted concurrently with the pump station repair efforts. If the repairs can be completed by the on-site responder, repairs will be made and the work order will be completed with appropriate data. If necessary, the Supervisory staff (Operations Supervisor and Planner/Scheduler or Division Engineer) will assist in procuring materials, resources, and planning support required to perform/complete the emergency work order. If repairs cannot be completed in house, they will be referred for external repair, rehabilitation, or replacement.

Since failure history is one of MSD's risk factors, periodically, CMMS data from CM and EM work orders will be analyzed to determine any necessary updates to condition and risk of pump station assets.

5.0 FORCE MAIN ASSET MANAGEMENT PERFORMANCE STANDARDS AND PROCEDURES

5.1 Program Overview

MSD's Pump Station Division processes for force mains are also incorporated into the District's asset management program to help ensure that the force mains are kept in good repair and function optimally. This aids in preserving capital investment while minimizing service interruptions. It also allows MSD to better understand how the system functions, how it works under various conditions, and what maintenance and capital improvements are necessary to achieve optimal system performance. The program for force mains combines preventive, predictive, corrective, and emergency maintenance strategies with industry best management practices in order to most effectively manage sewer system asset inventory.

MSD currently owns and maintains 130 miles of force mains. In addition to force mains carrying flow from MSD owned pump stations in the sewer and ORS systems, MSD also owns and maintains force mains built by developers for privately owned low pressure pump stations serving individual residences or businesses. MSD is responsible for the portion of these lower risk force mains that are on public property or MSD acquired easements from the point where it can be isolated from the home to where it ties into MSD sewers.

MSD has developed and will periodically update a hierarchical, prioritized ranking of force mains based on estimated risk of failure and consequences of failure. Factors included in risk of failure are typically linked to force main physical attributes. Consequence of failure is typically linked to the location of the force main and design factors. Factors utilized as part of this criticality rating process include the following:

- daily flows
- age
- material
- size
- maintenance history

- location, including population affected by failures
- environmental concerns

As more information on force main performance becomes available, the risk categorization may need to be updated and the force main inspection frequency will be adjusted accordingly.

MSD will perform periodic visual inspections on all force mains and non-destructive testing on those of medium and high risk in accordance with the requirements of the Consent Decree. Identified repairs will be performed and documented in the CMMS. Each one of these processes is further defined in the following sections.

5.2 Force Main Visual Inspections

The work flow diagram for force main visual inspections is included as Appendix M. Each force main has been prioritized in the CMMS as either low, medium, or high risk as discussed in the overview above. Force main assets ranked in the high-risk tier will be visually inspected annually. Assets ranked in the medium risk tier will be visually inspected every two (2) years. Assets ranked in the low risk tier will be visually inspected every five (5) years. Planners generate and schedule the required inspection work orders from preventive maintenance plans established in the CMMS.

Force main visual inspections are performed by Pump Station Division personnel and consist of a visual inspection of the force main alignment looking for signs of leakage or ground shifting that might indicate problems with the force main. During the initial inspection, staff also locates each force main to GPS survey quality accuracy in order to verify GIS maps. As part of these inspections, MSD personnel will determine the condition of force main appurtenances including air release valves, isolation valves, cleanouts, emergency truck connections, and valve junction boxes. Asset information in the CMMS for each of these appurtenances will also be validated. Their condition will be determined using an established rating system. Updated information and condition rating will be input into the CMMS. Pictures of visible force main appurtenances are taken and attached to asset records in the CMMS. GPS survey information for the force main is forwarded to the GIS department and maps are updated if necessary.

Follow up corrective maintenance work orders will be entered into the CMMS for any appurtenance defect with a condition rating of ‘4’ or ‘5’ identified during inspection. These work orders will be tracked for timely completion. Depending on priority of the identified work, it will be handled as either an emergency by Pump Station Division personnel or go through the MSD’s repair, rehabilitation, and replacement process as discussed in section 3.4 of this CMOM Program Plan. If signs of leakage are found during an inspection, immediate corrective action is initiated.

5.3 Force Main Non-Destructive Testing (NDT)

Force main non-destructive testing (NDT) consists of condition assessments that determine the condition of internal portions of the force main piping. This work will be

performed primarily by other entities (specialized vendors/consultants), under the overall direction of Pump Station Division personnel in the early years of the program. Pump Station Division personnel will perform a limited amount of non-destructive testing inspections. As the program matures, the District will evaluate utilizing MSD employees for additional amounts of non-destructive testing. Condition assessments will employ a variety of tools and methodologies. The District will depend heavily on externally provided engineering services for recommendations as to what specialized technologies, vendors, and specialized assessment techniques to utilize. The work flow procedure for force main non-destructive testing is included in Appendix N.

The CMMS asset database contains the force main's current risk classification and condition rating. Force mains ranked in the high-risk tier will be tested every three (3) years. Assets ranked in the medium-risk tier will be inspected every six (6) years. Assets ranked in the low-risk tier do not require testing since they are smaller, the materials and economics make this type of testing impractical. Testing for low risk force mains is not required under the terms of the Consent Decree. Planners generate and schedule the required inspection work orders from preventive maintenance plans established in the CMMS.

5.3.1 Force Main NDT – Engineering Services

MSD has contracted with an engineering services provider who will perform 'table top' analysis of each force main. Information on the force main in the CMMS, record drawings (force main plan and profile information), and other information as needed and available will be examined. The primary goal of a 'table top' analysis is to help focus pipe non-destructive testing on areas which are at highest risk for premature asset failure.

"Table top analysis" can consist of the following typical activities:

- Examination of force main break history, to include locations, root causes, and frequency.
- Review past condition assessments, i.e. previous Sahara in-line pipe assessments, CCTV results, other previously utilized tools.
- Review record drawings, especially profile information, for high risk pipe configurations (unprotected high points with no ARV for example). Depth of cover is a consideration.
- Review easement and right of way (ROW) information for accessibility issues.
- Review CMMS for pipe appurtenance condition.
- District supplied condition monitoring information, such as pressure monitoring information or volumetric flow rate data collection information.

The Engineering services provider will recommend suitable techniques, methods, technologies, and procedures for field non-destructive testing specific to each asset or class of assets. They will also identify needed infrastructure changes, both external (recommended to be performed by others) and internal (performed by District personnel), to facilitate the non-destructive testing. Cost estimates and scope of work details specific to each force main will be included for both infrastructure changes and the recommended nondestructive testing.

5.3.2 Field Work

Pump Station Division personnel resource, schedule, and execute agreed infrastructure changes identified from the engineering service provider's 'table top analysis' phase to prepare for the nondestructive testing. For example, access manholes or hot taps may be needed. District personnel or the engineering services provider will coordinate vendor/contractor work.

Nondestructive testing will be performed by MSD or contractor personnel. Testing will involve 'intrusive' and 'non-intrusive' methods. Field work non-destructive testing, i.e. condition assessment might consist of the following typical activities:

- Pipe coupon examination
- Ultra-sonic thickness testing at designated locations
- Acoustic in-line assessment tools for leak detection or gas pocket location
- Transient pressure data collection and analysis
- Pressure and flow rate data collection and analysis

5.3.3 Non Destructive Testing Analysis

MSD or its engineering services provider will utilize non-destructive testing information obtained during field work to estimate remaining asset life and generate detailed recommendations including cost estimates for repairing, replacing, or rehabilitating a force main. Nondestructive test results will also identify if there are any defects that need to be corrected using the emergency repair or the expedited 1 year defect repair process required by the Consent Decree.

Certain tests such as thickness or coupon testing will allow condition rating on MSD's '1' to '5' scale. These ratings will be included on the work order and asset records in the CMMS. Force main condition ratings will be used to update a risk based, prioritized Capital Improvements and Replacements Program (CIRP) list for force main RRR. District personnel will also re-evaluate the force main's risk classification utilizing this information and adjust frequency of periodic condition assessments accordingly. Any changes to the risk classification will be made on the force main's asset record in the CMMS. Force main visual inspections or continued non-destructive testing frequencies will be modified in the CMMS if risk classification changes.

As testing information becomes available or trends are analyzed, recommend changes to current design standards, construction phase practices, operations and maintenance practices may be made in order to increase asset life cycle, reduce overall life cycle cost, and decrease probability of premature asset failure.

5.4 Force Main Inspection Follow Up Repairs

Any force main defects that result in a condition rating of 5 will be included in the expedited process for repair within 1 year.

The District will generate, and periodically update, contingency force main Emergency Response Plans (ERP) that address critical, high risk assets in very specific ways, and lower tier, medium risk, assets in more generic ways. The District will establish pre-staged, pre-stocked 'repair kits' of materials for such repairs. These repairs kits would be items listed in the CMMS inventory listing and identified for each force main. The District will also establish and identify a contractor support plan that addresses multiple failure modes (point repair support - excavation only, or more major repairs requiring extensive outside vendor/contractor support). The engineering services provider will generate these force main Emergency Response Plans (ERP) over a three (3) year period while concurrently developing force main non-destructive testing plans and reviewing results.

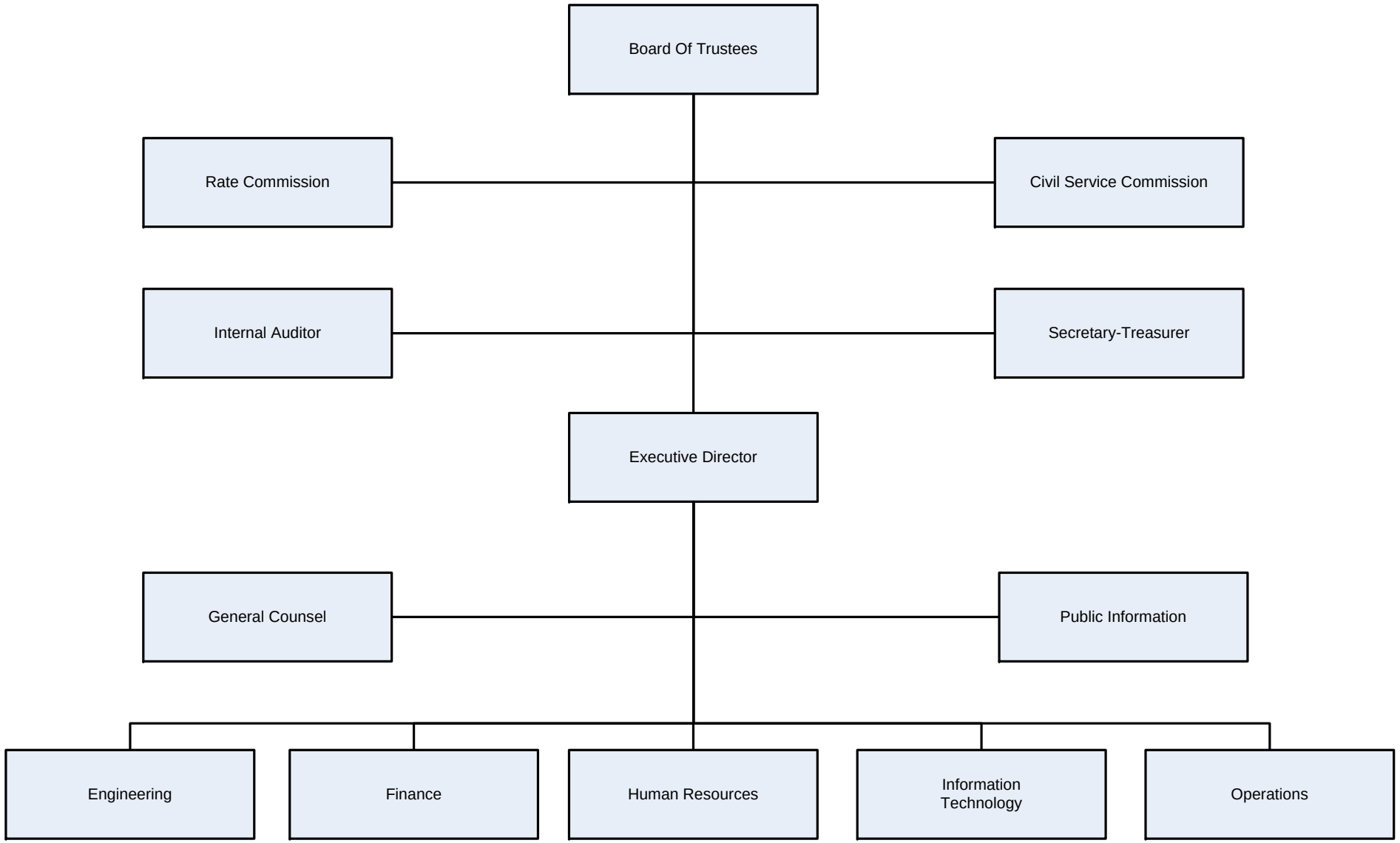
6.0 CONCLUSION

The Metropolitan St. Louis Sewer District is committed to utilizing an asset management approach for meeting defined service levels and maintaining sewer system assets. As new information, technologies and techniques become available, regulatory requirements are updated, and customer priorities and resources change, this CMOM Program Plan will be evaluated for appropriate updates. These updates will focus on optimizing the use of limited resources to meet mutual goals for a sustainable sewer system infrastructure.

MSD has provided this CMOM Program Plan to comply with Paragraphs V.G.31, 32, and 33 of Consent Decree Case No. 4:07-CV-1120. This document is the formal submission of the CMOM Program Plan, and as noted on the cover page, is being submitted within six months of the Consent Decree Effective Date. This plan does not become effective until 90 days after approval by the EPA. Included with this Program Plan are the various workflows requested in the Consent Decree. These workflows represent the most current version as developed and used by MSD at the time of this submittal. MSD anticipates that these workflows as well as this Program Plan will need to be revised and/or refined from time to time as MSD identifies better methods for achieving service levels and maintaining assets. Any changes impacting Performance Standards to reach service levels will be noted in the Annual Report and MSD may request a modification of the Performance Standards to reach the service levels which would become effective upon EPA approval.

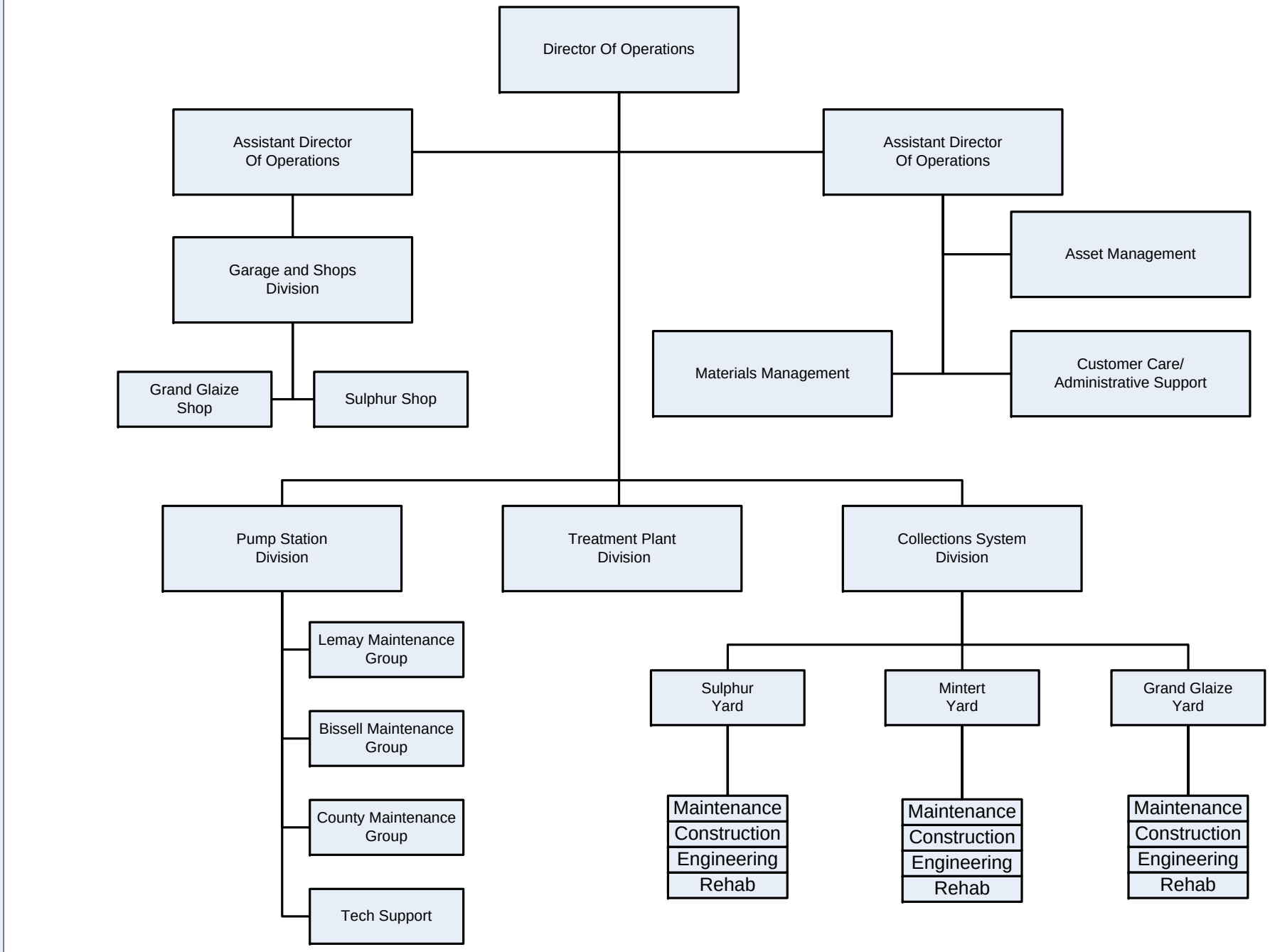
MSD Organization Chart

Appendix A.1



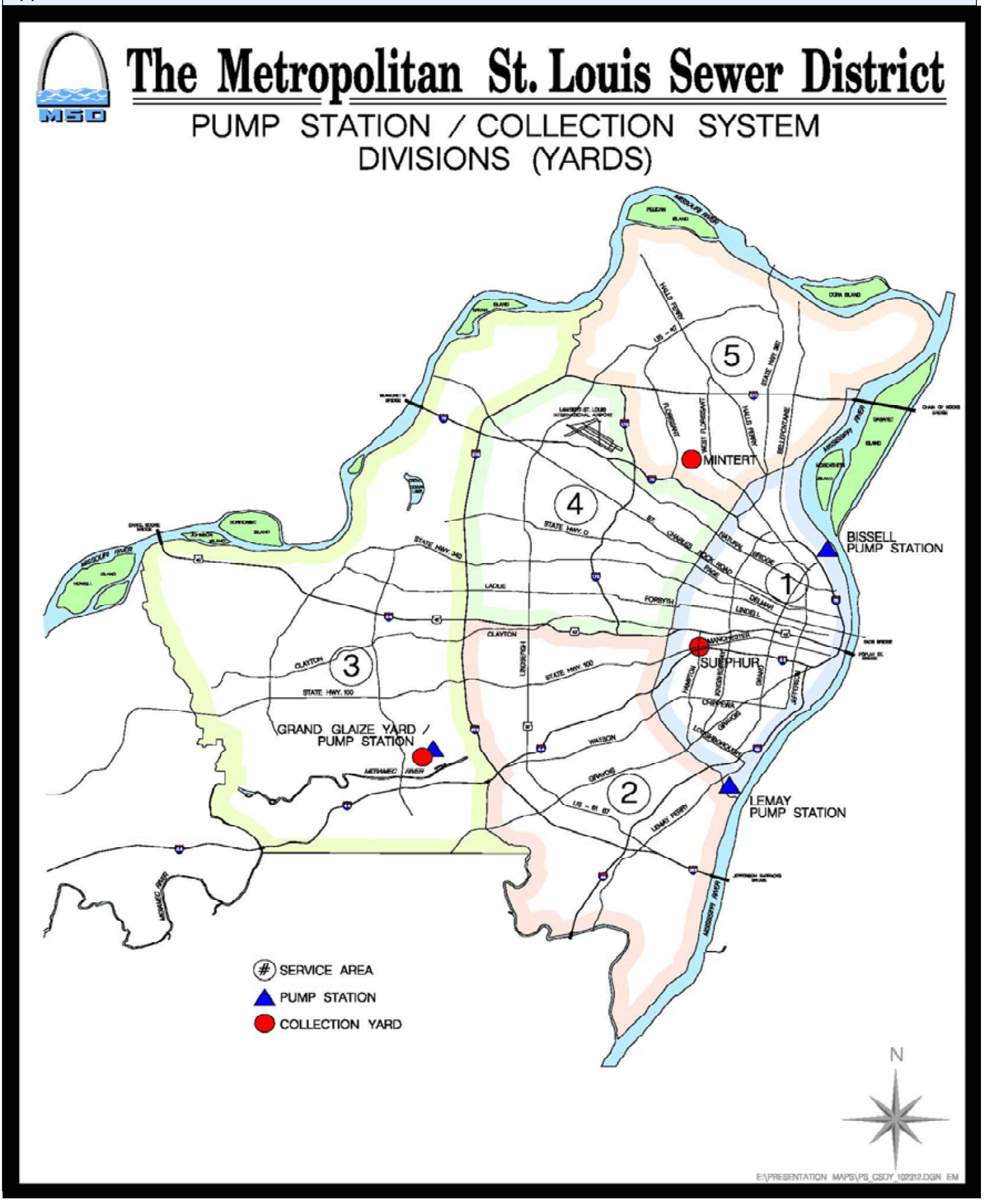
Operations Organization Chart

Appendix A.2



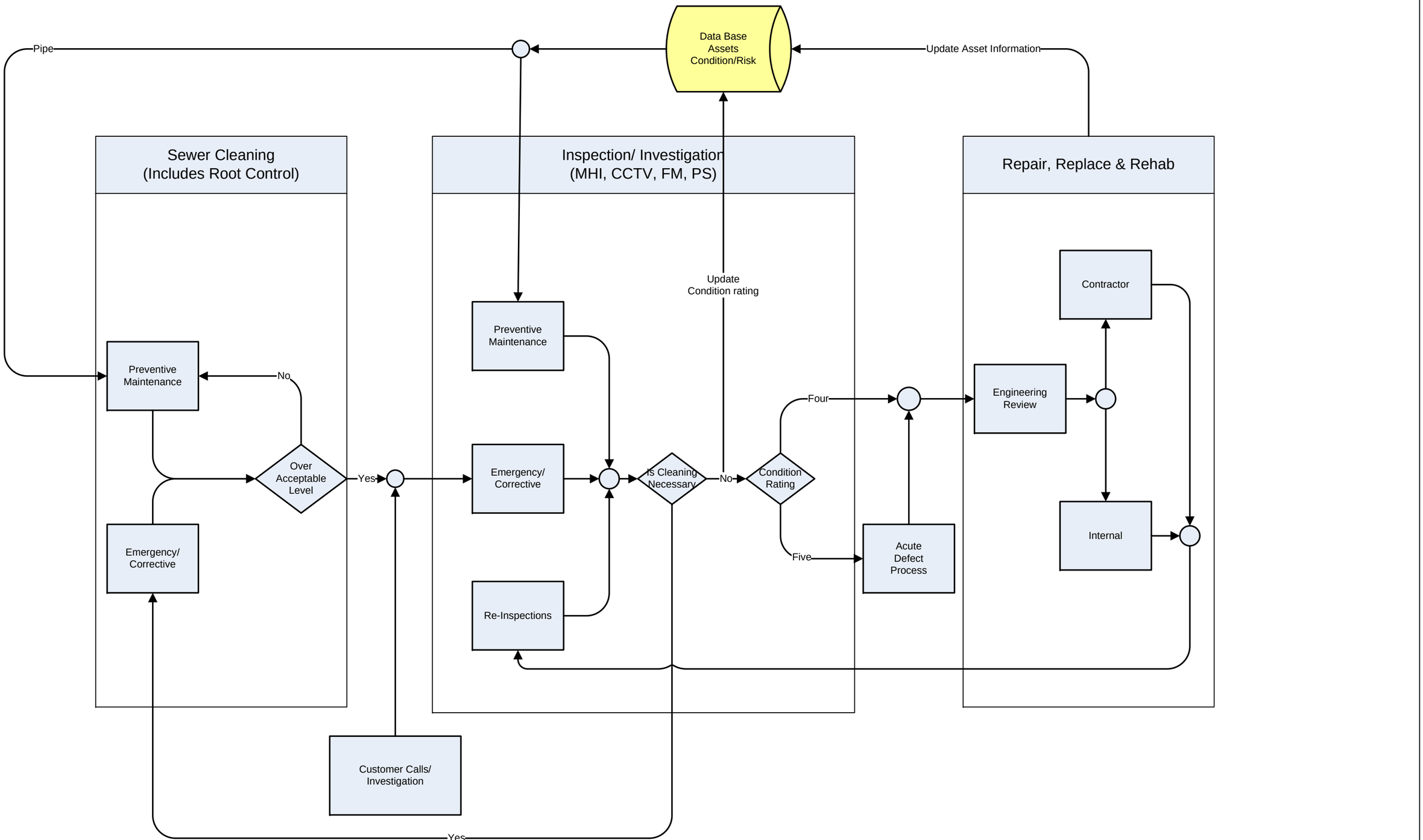
Pump Station / Collection System Division (Yards)

Appendix A.3



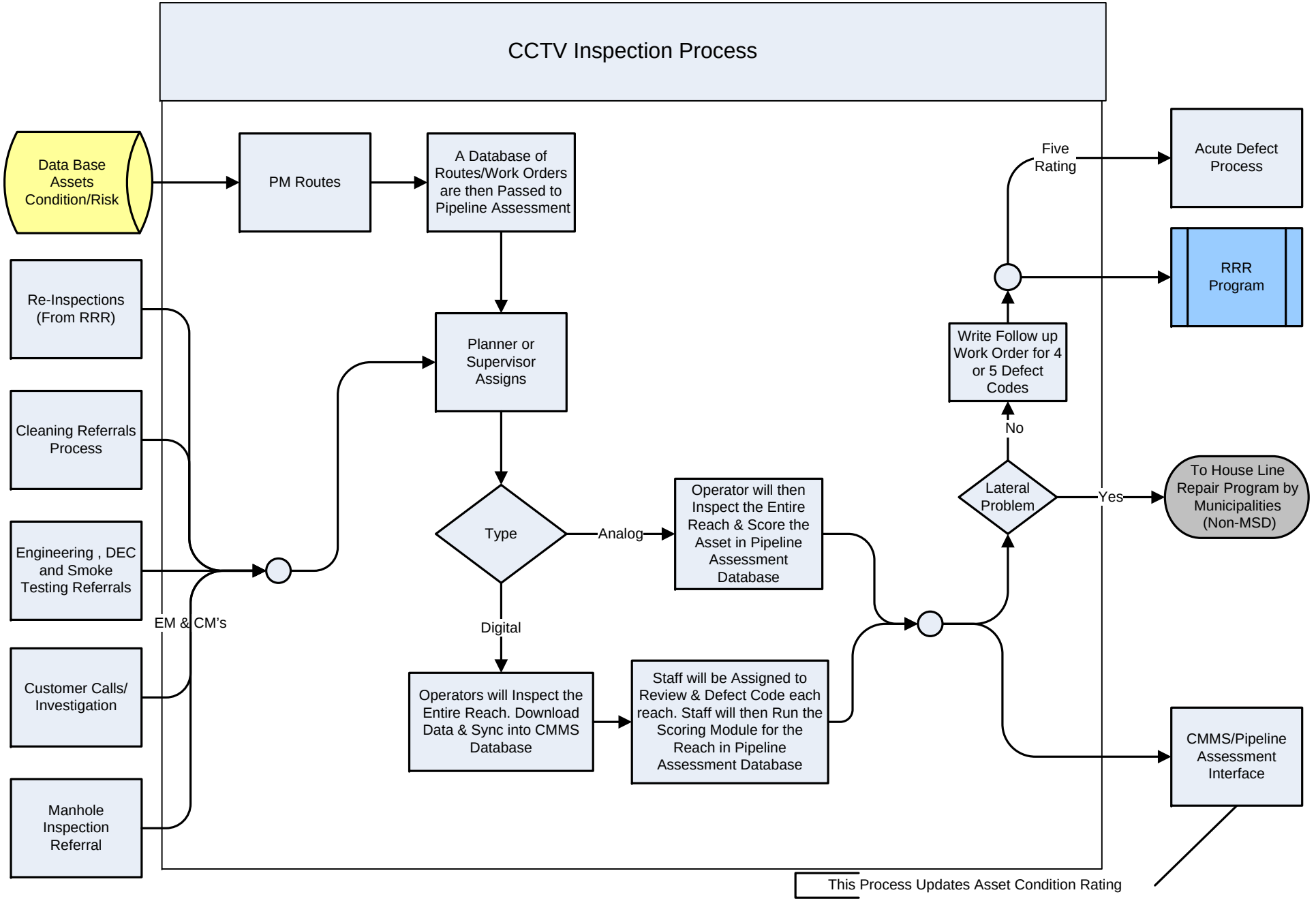
CMOM Overview

Appendix B



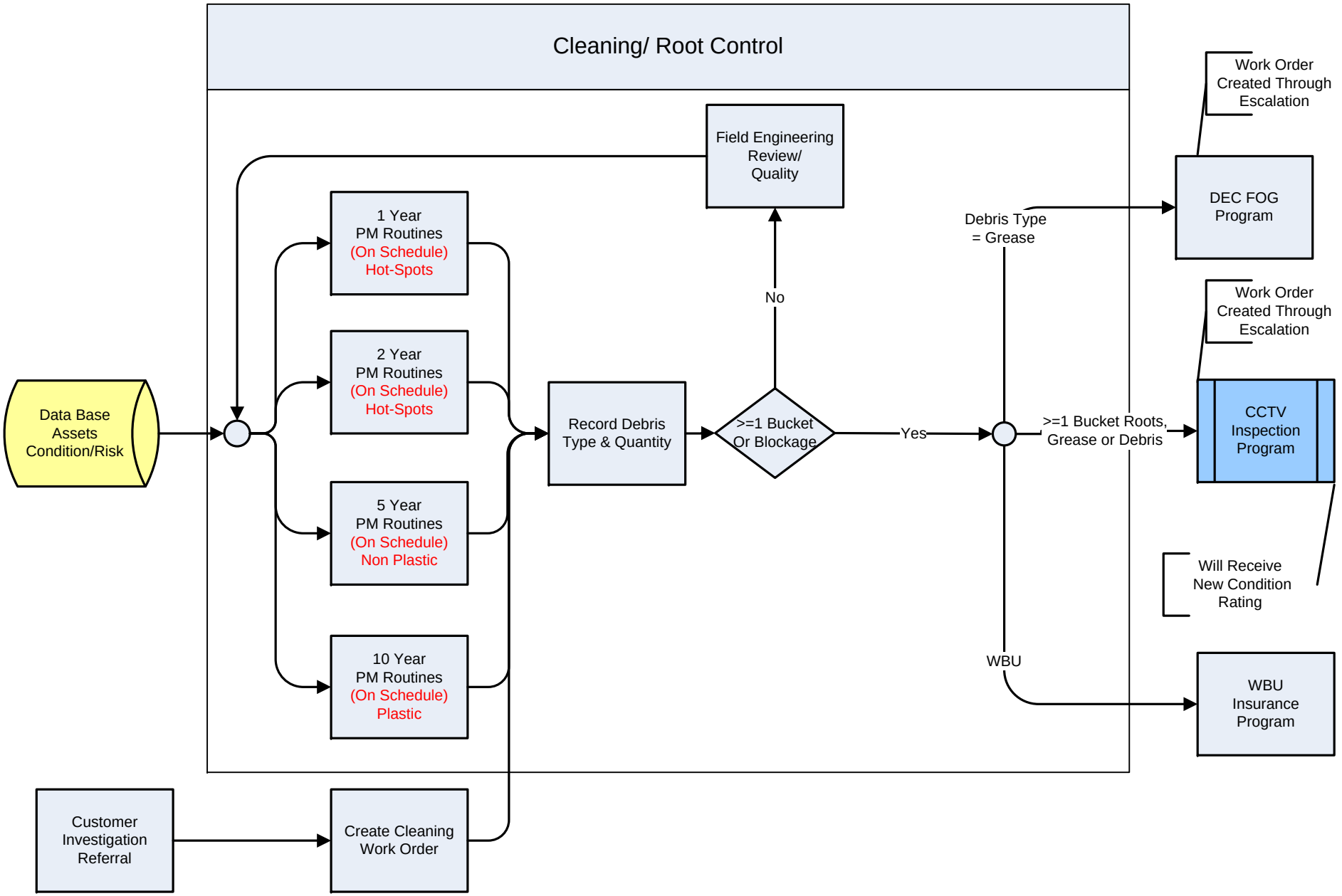
CMOM Gravity Sewer CCTV Inspection Process

Appendix C



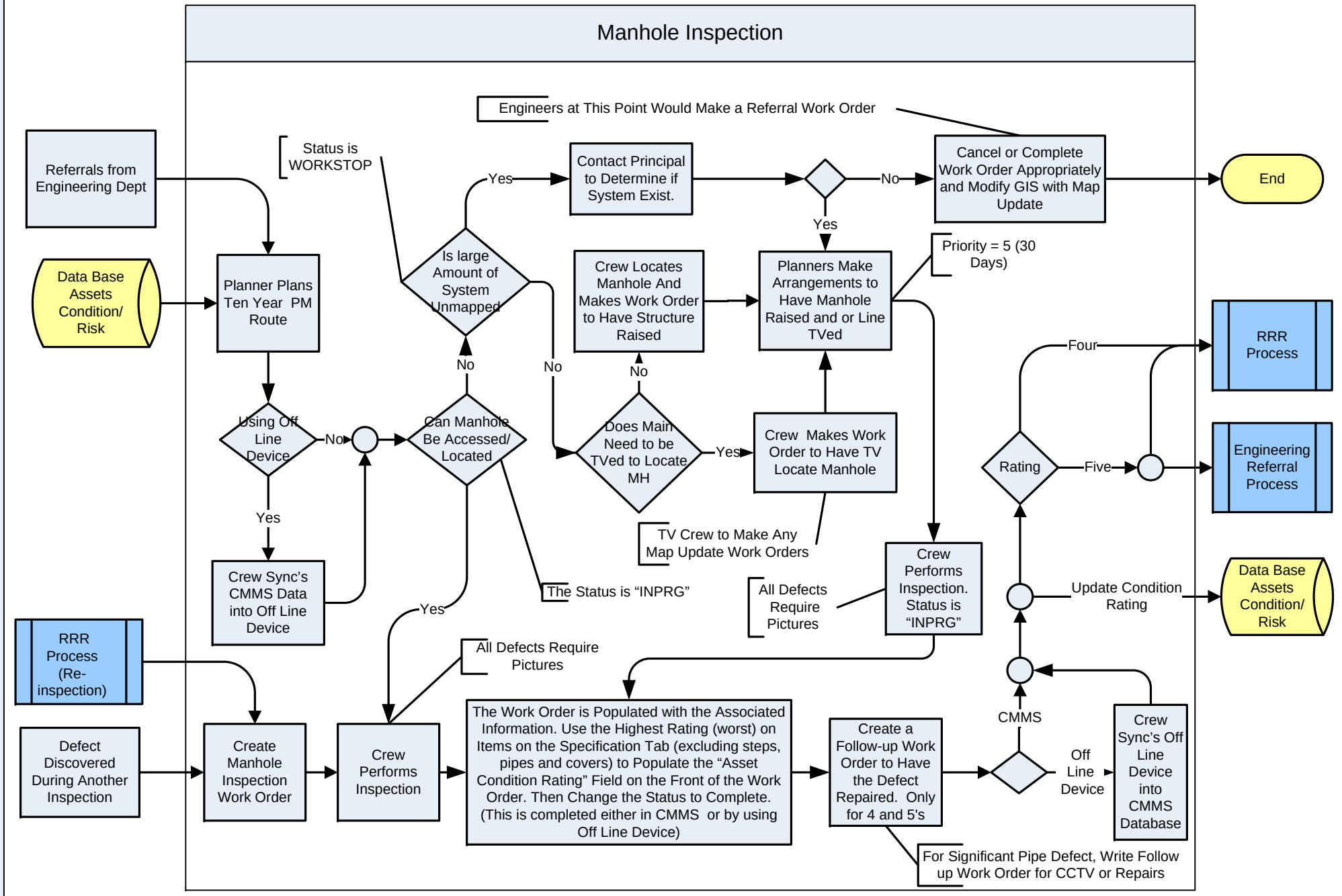
CMOM Sewer Cleaning and Root Control Process

Appendix D



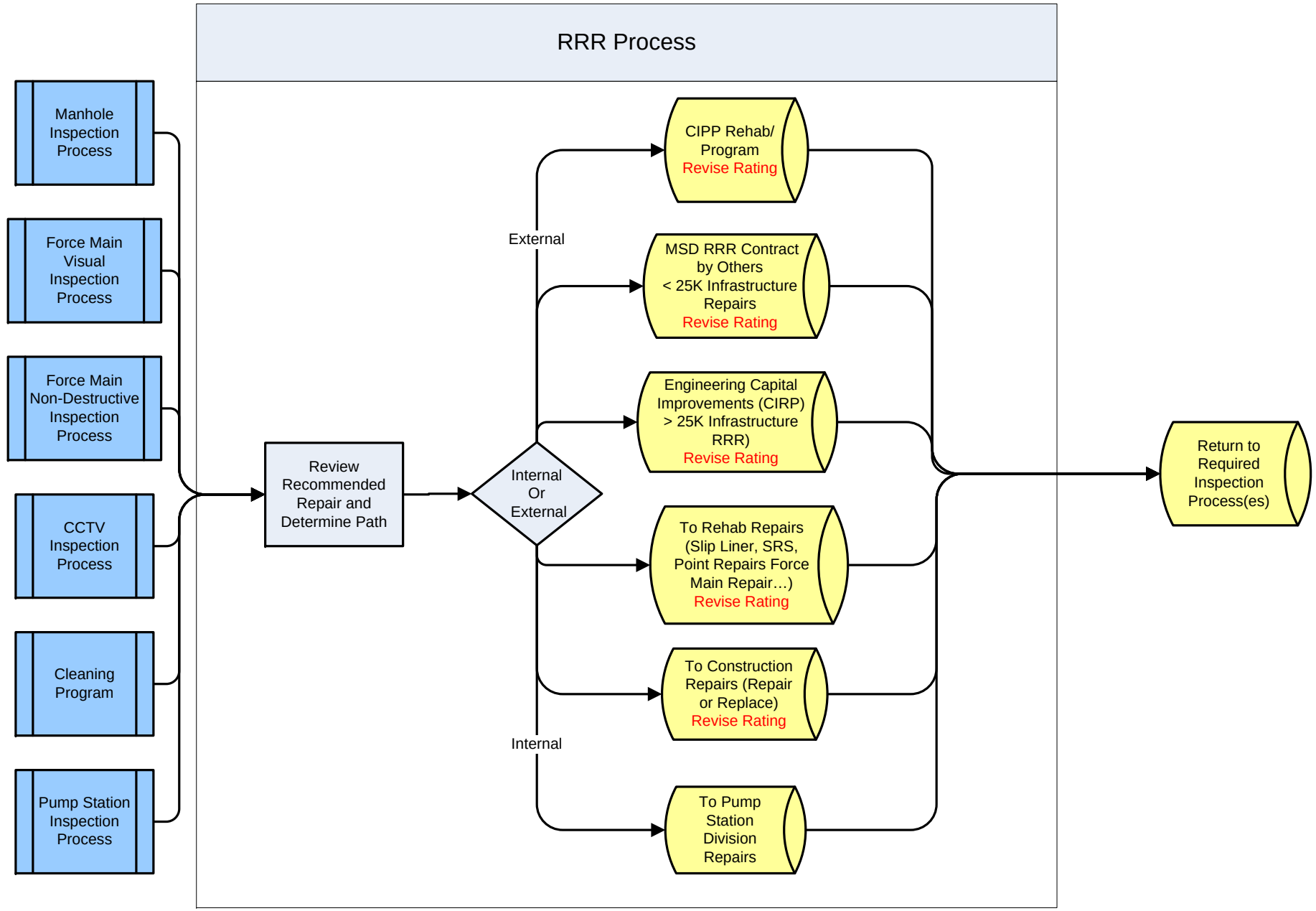
CMOM Manhole Inspection Process

Appendix E



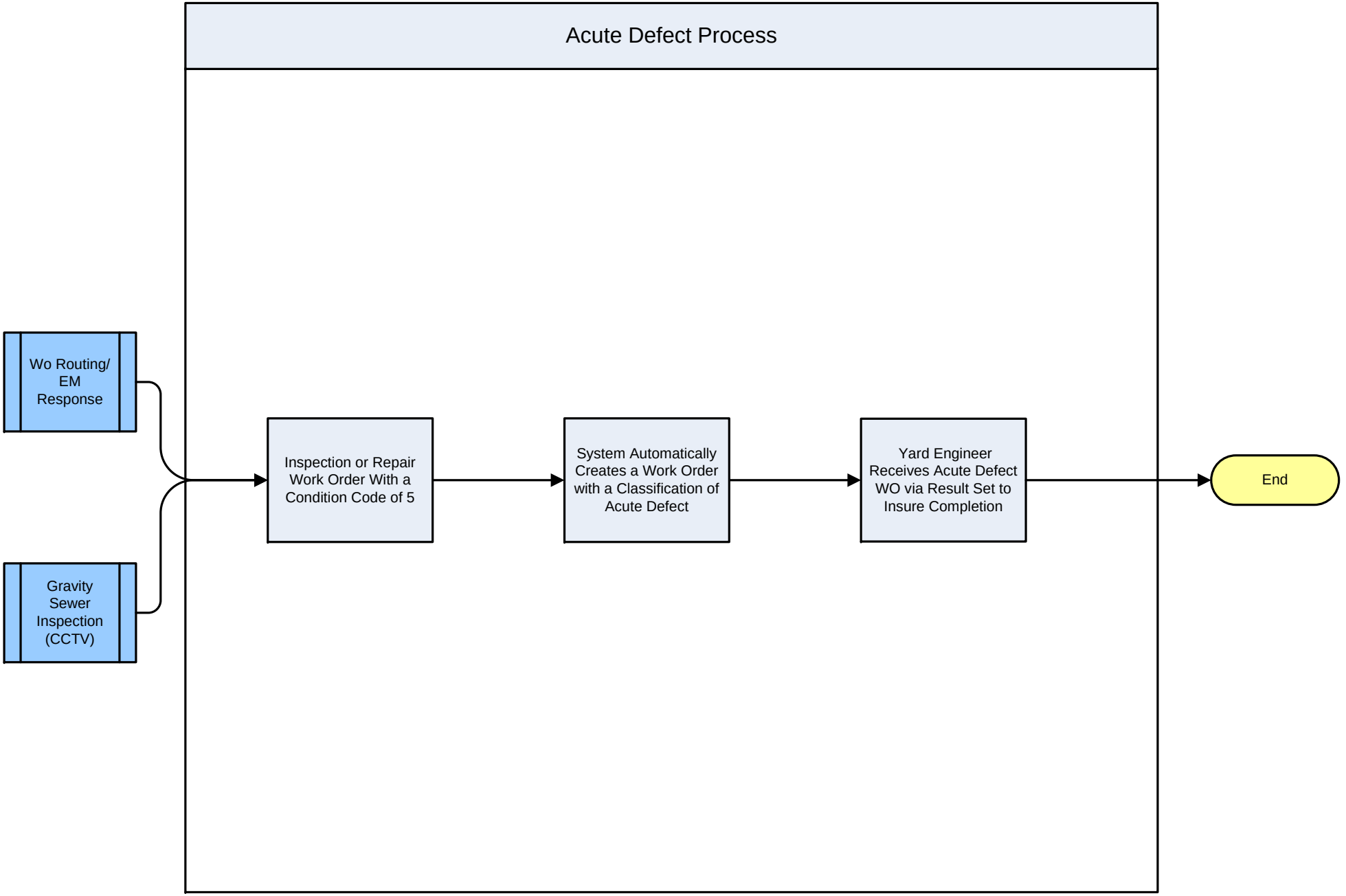
CMOM Rehab, Repair and Replace Process

Appendix F



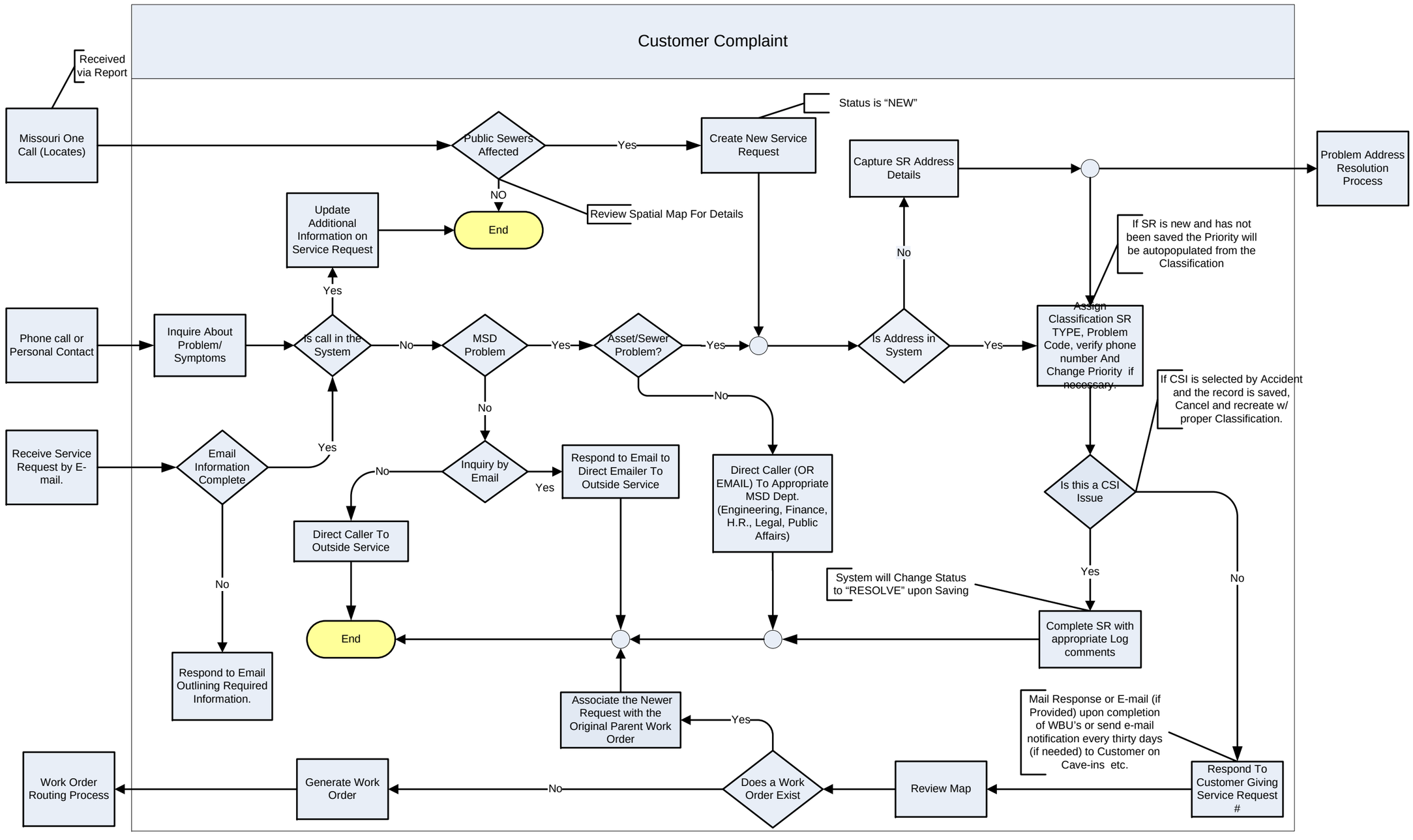
CMOM Acute Defect Process

Appendix G

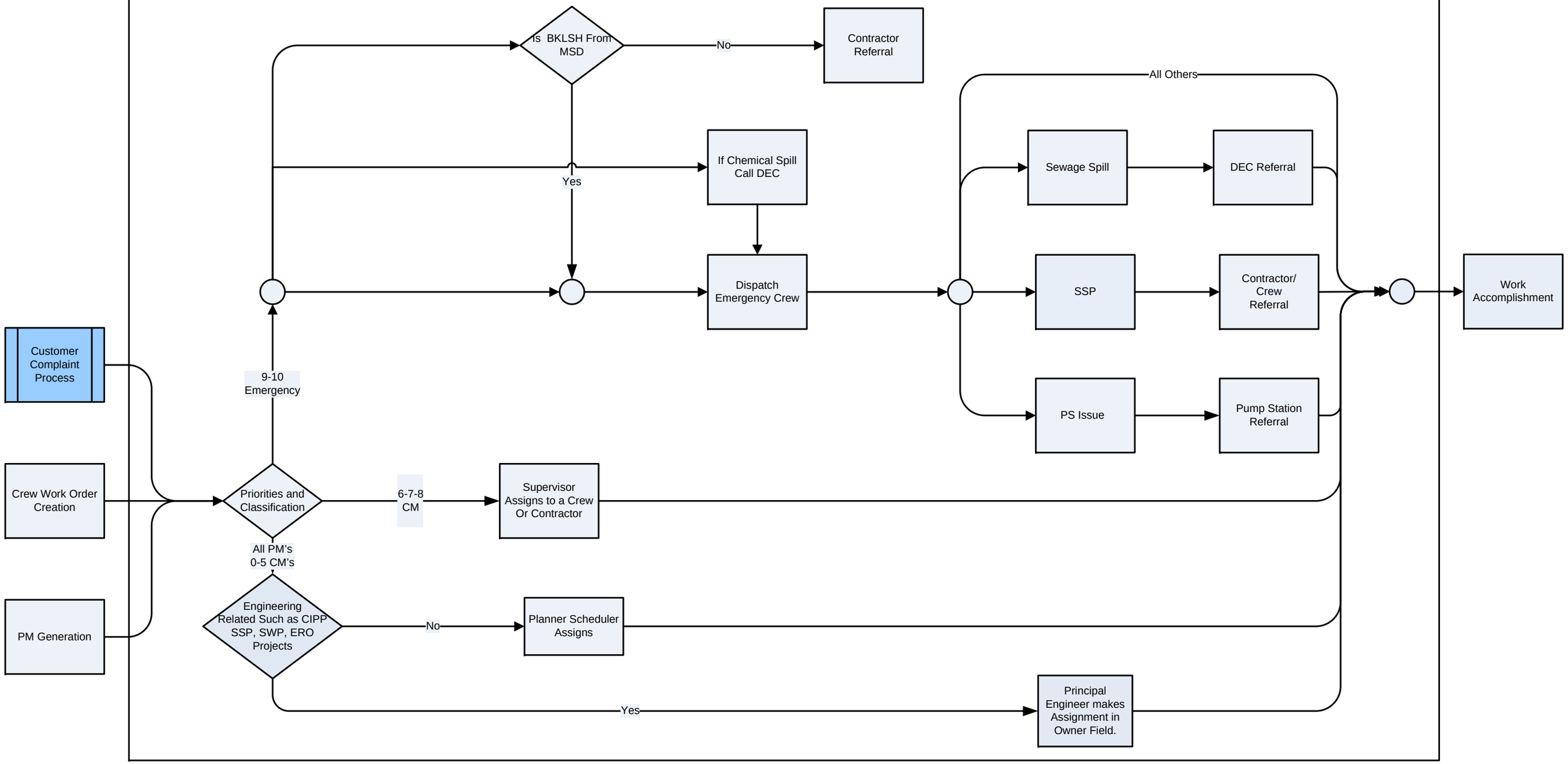


CMOM Customer Complaint Process

Appendix H

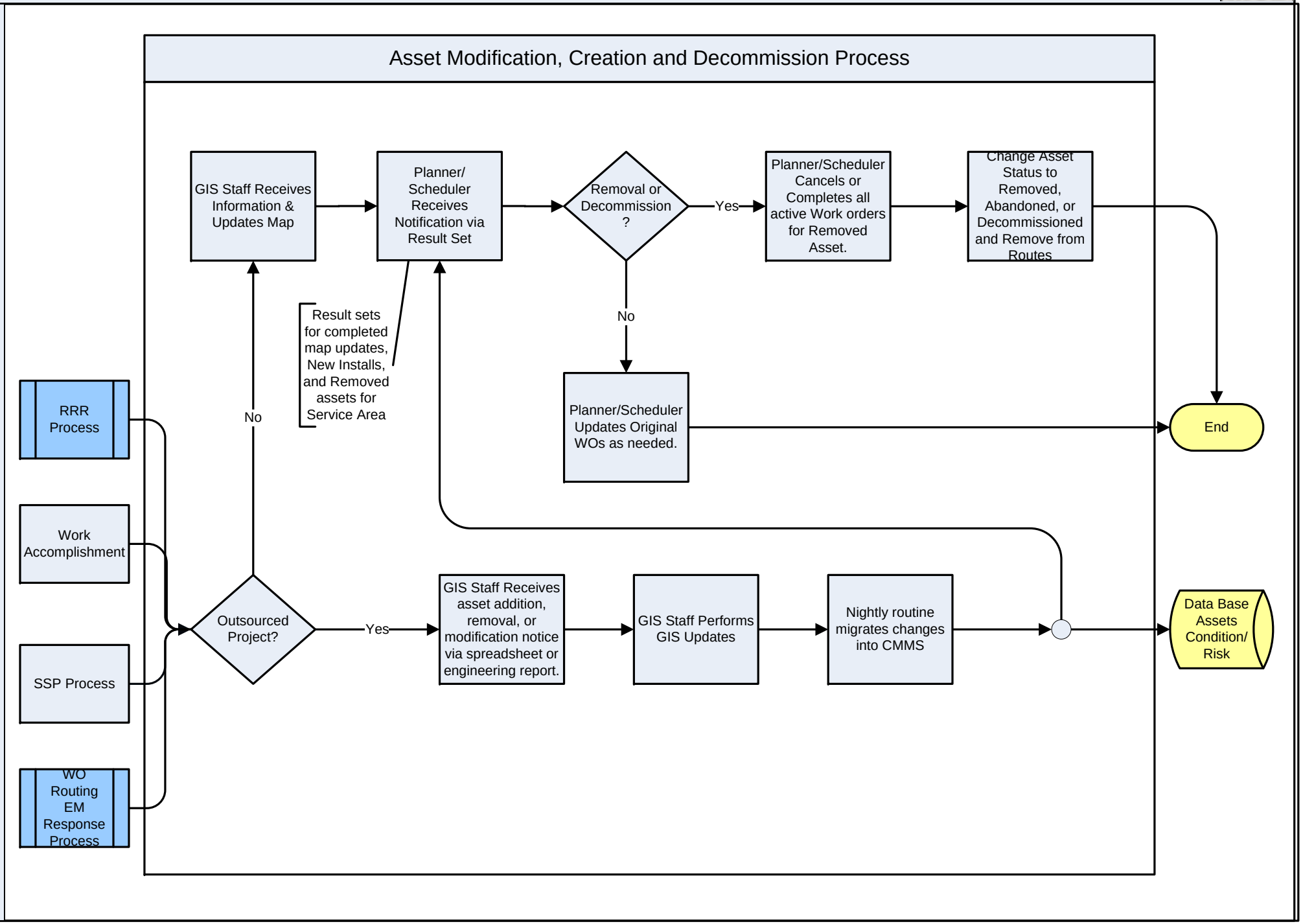


Work Order Routing/Emergency Response Process



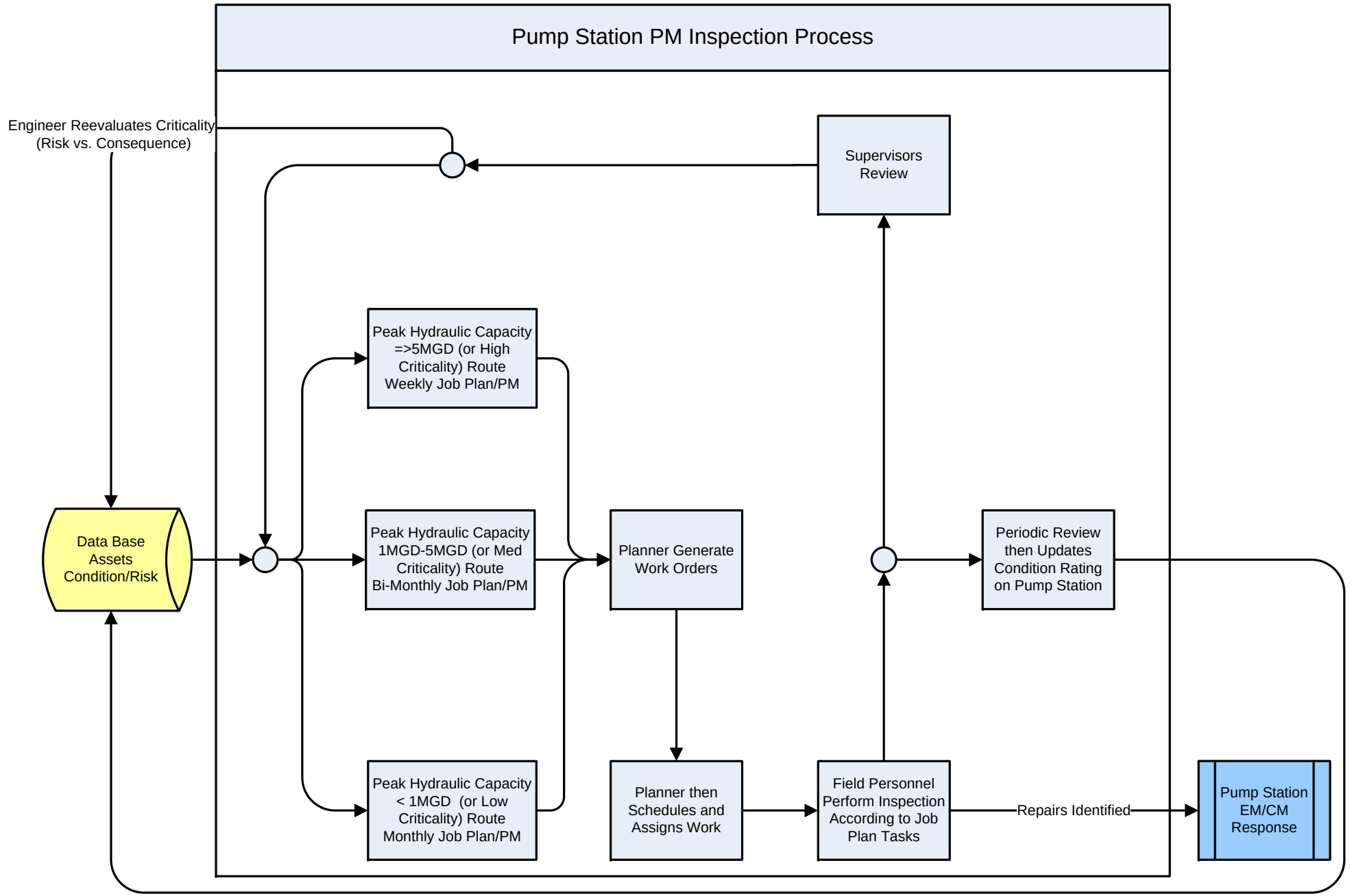
CMOM Asset Modification, Creation and Decommission Process

Appendix J



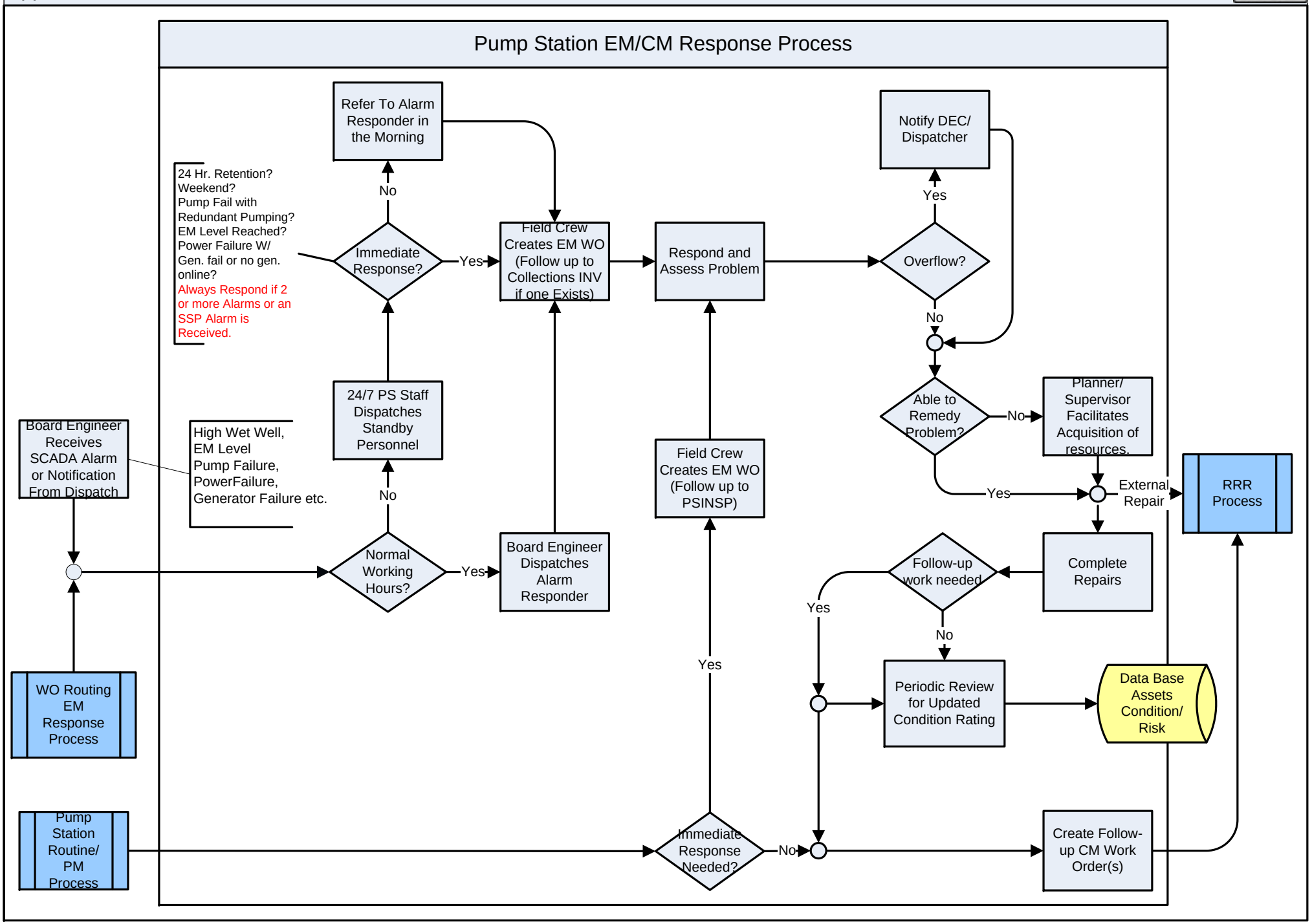
CMOM Pump Station Routine/PM Inspection Process

Appendix K



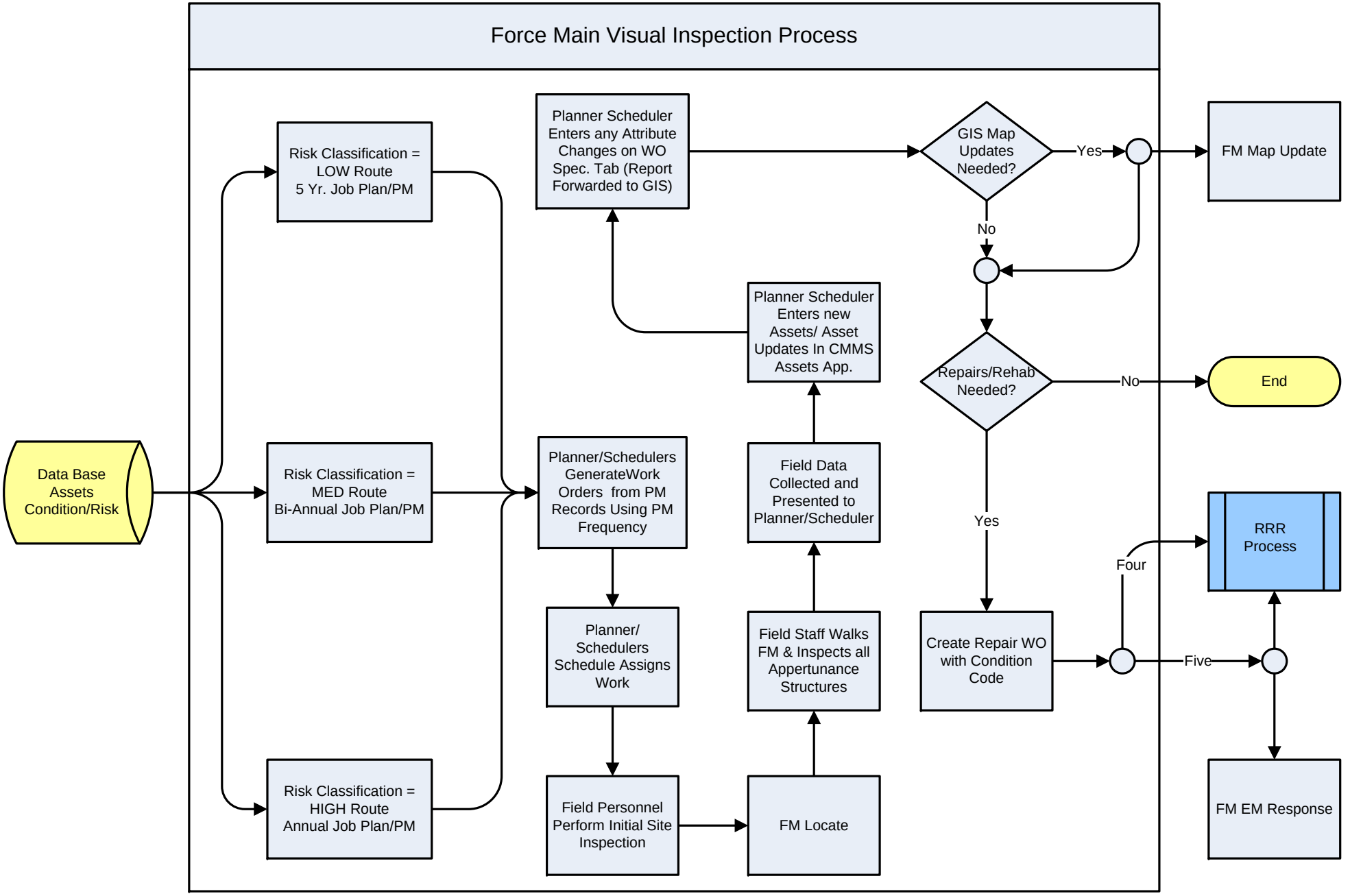
CMOM Pump Station EM/CM Response Process

Appendix L



CMOM Force Main Visual Inspection Process

Appendix M



CMOM Force Main Non-Destructive Test Inspection Process

Appendix N